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**Cho et al.**

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(54) **IMAGE AND LIGHT PROJECTION**

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**G03B 21/20** (2006.01)

(Continued)

(52) **U.S. Cl.**

CPC ..... **G03B 21/145** (2013.01); **F21V 21/02** (2013.01); **G02B 27/0977** (2013.01); **G03B 21/206** (2013.01); **G03B 21/208** (2013.01); **G03B 21/2033** (2013.01); **G03B 21/2053** (2013.01); **G03B 21/2066** (2013.01); **G03B 21/28** (2013.01); **G03B 29/00** (2013.01); **G06F 3/017** (2013.01); **G08G 1/0967** (2013.01); **H04N 9/3141** (2013.01); **F21Y 2115/10** (2016.08)

(58) **Field of Classification Search**

CPC .. G03B 21/14; G03B 21/145; G03B 21/2033; G03B 21/206; G03B 21/2066; G02B 27/0977  
USPC ..... 353/79, 94, 122  
See application file for complete search history.

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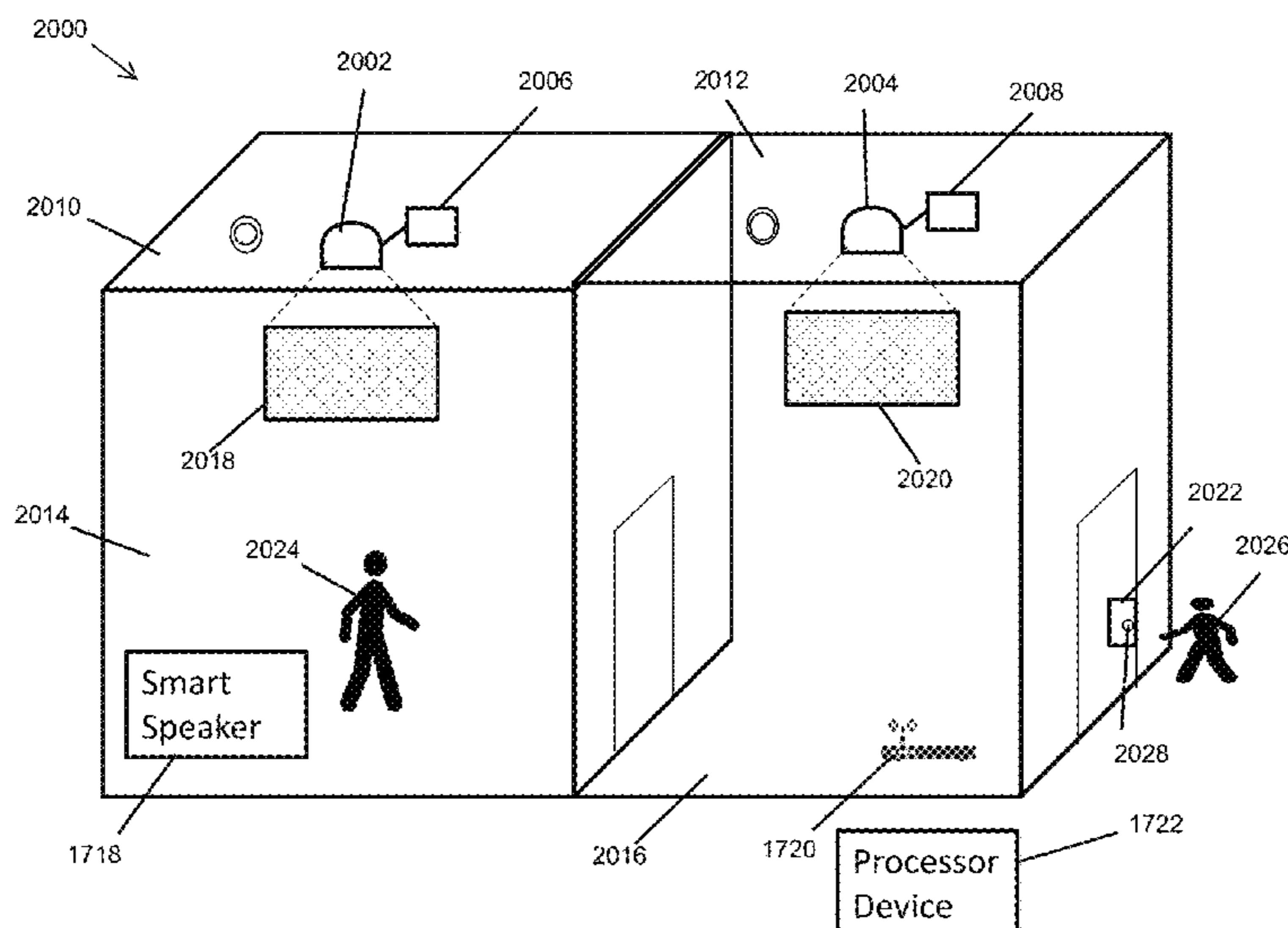
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(57) **ABSTRACT**

A projection system includes a recessed projection fixture that includes a lighting module configured to emit a light and a projection module configured to project an image. The light emitted by the lighting module is used for projecting the image and for illumination. The projection system further includes a sensor, where the projection module projects the image in response to an occupancy detection by the sensor. The recessed projection fixture is oriented to direct the image toward a surface below the recessed projection fixture.

**20 Claims, 29 Drawing Sheets**



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*G03B 21/28* (2006.01)  
*H04N 9/31* (2006.01)  
*G03B 29/00* (2006.01)  
*F21V 21/02* (2006.01)  
*G08G 1/0967* (2006.01)  
*G06F 3/01* (2006.01)  
*F21Y 115/10* (2016.01)

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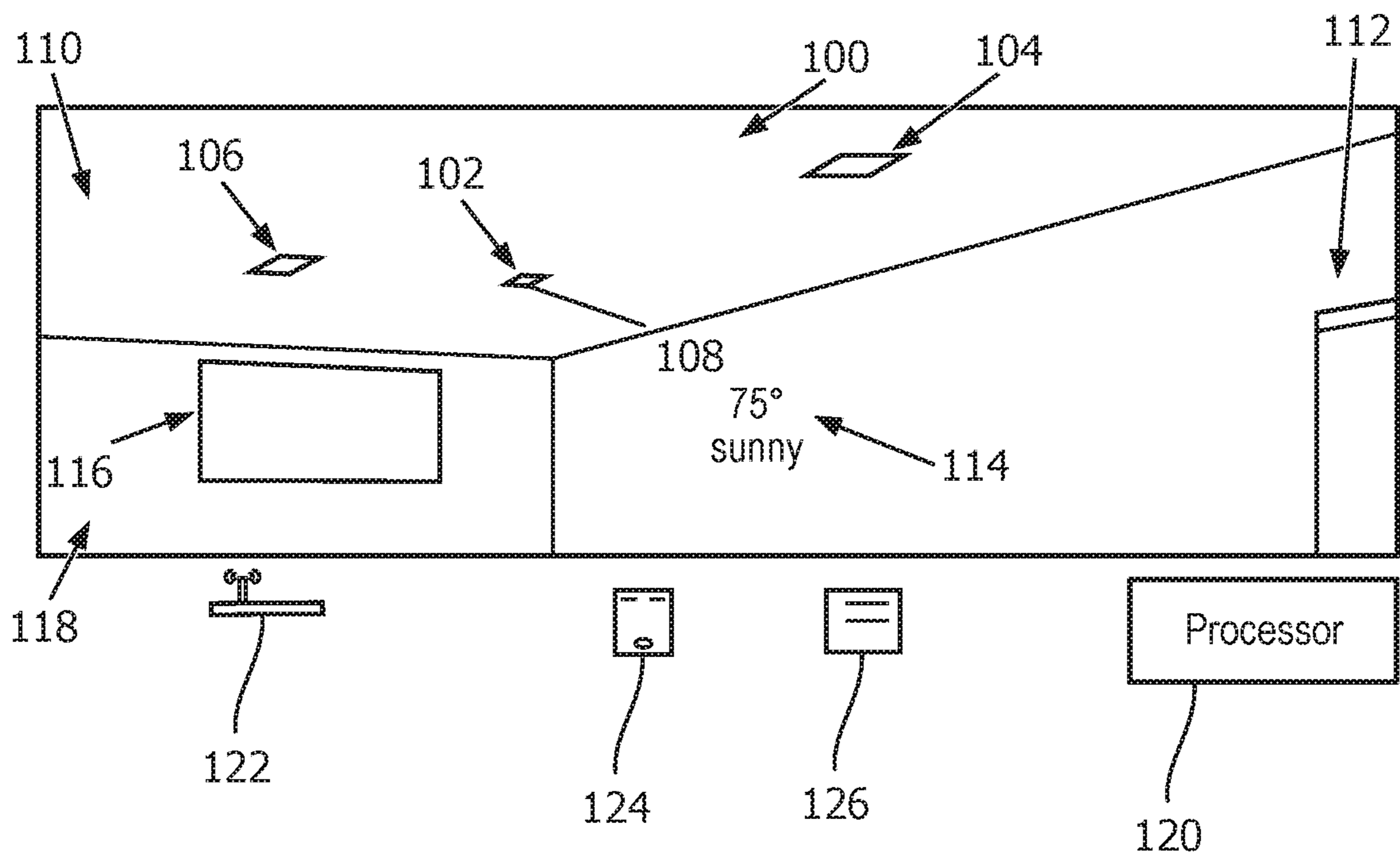


FIG. 1

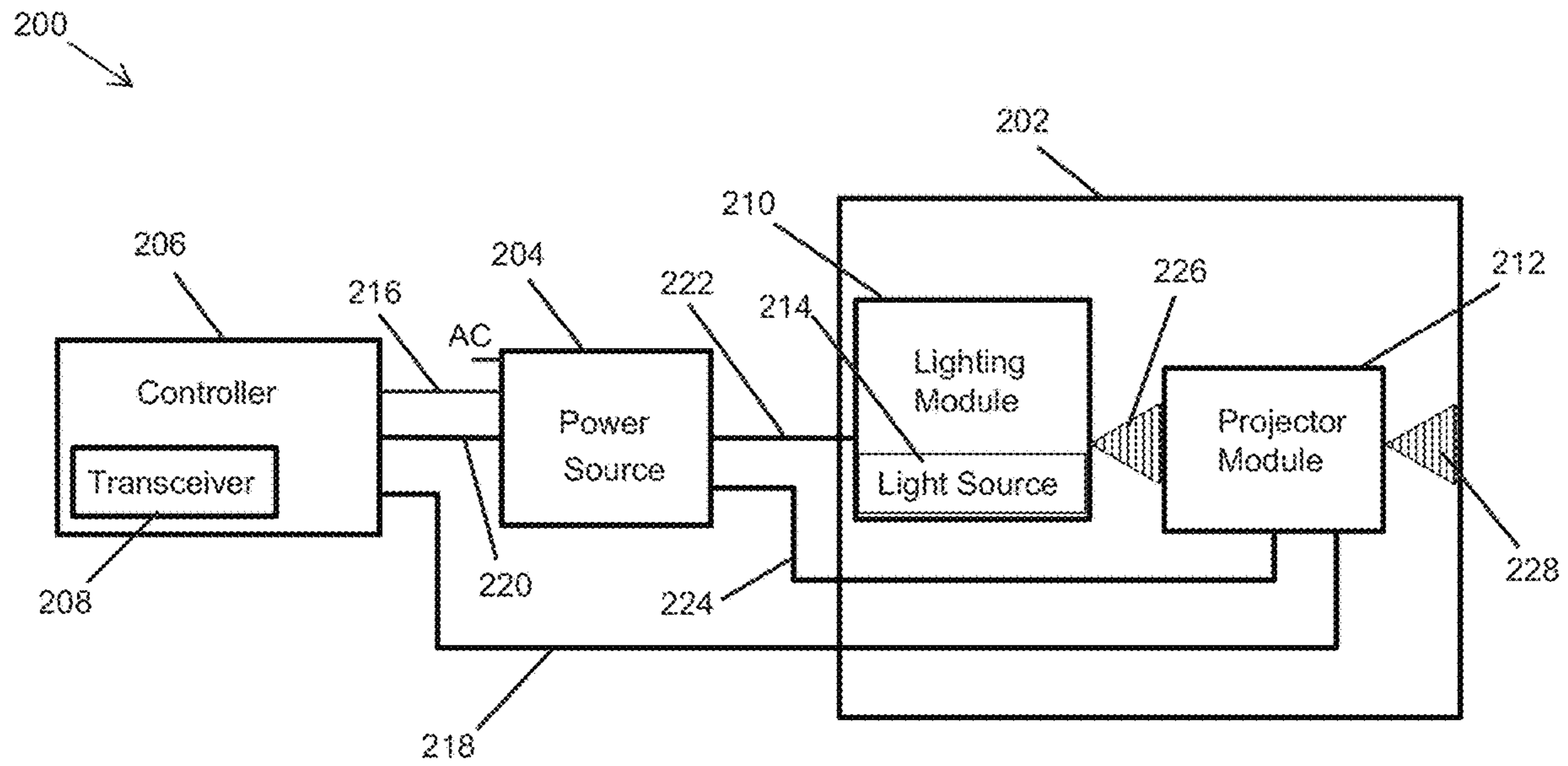


FIG. 2

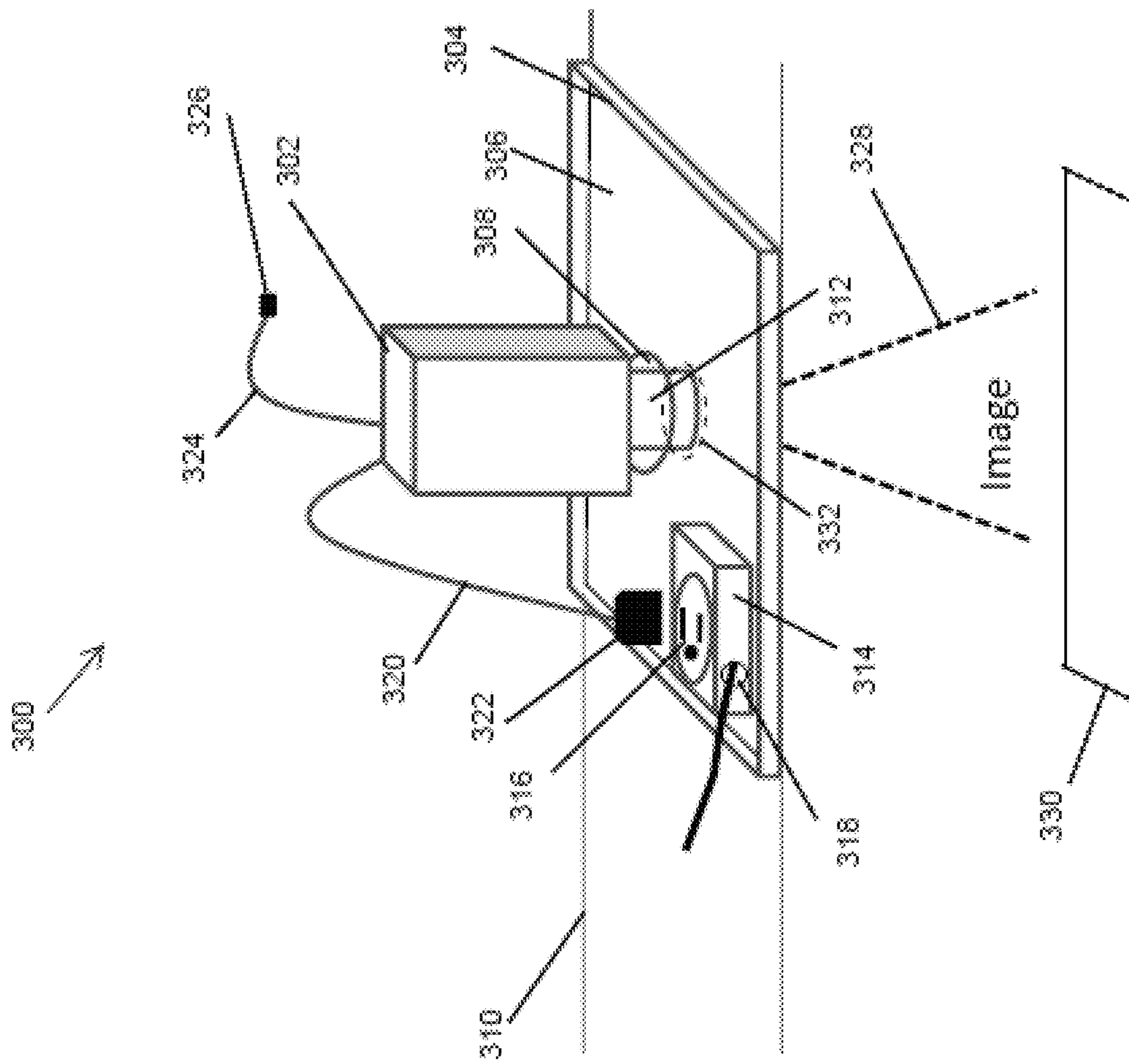


FIG. 3

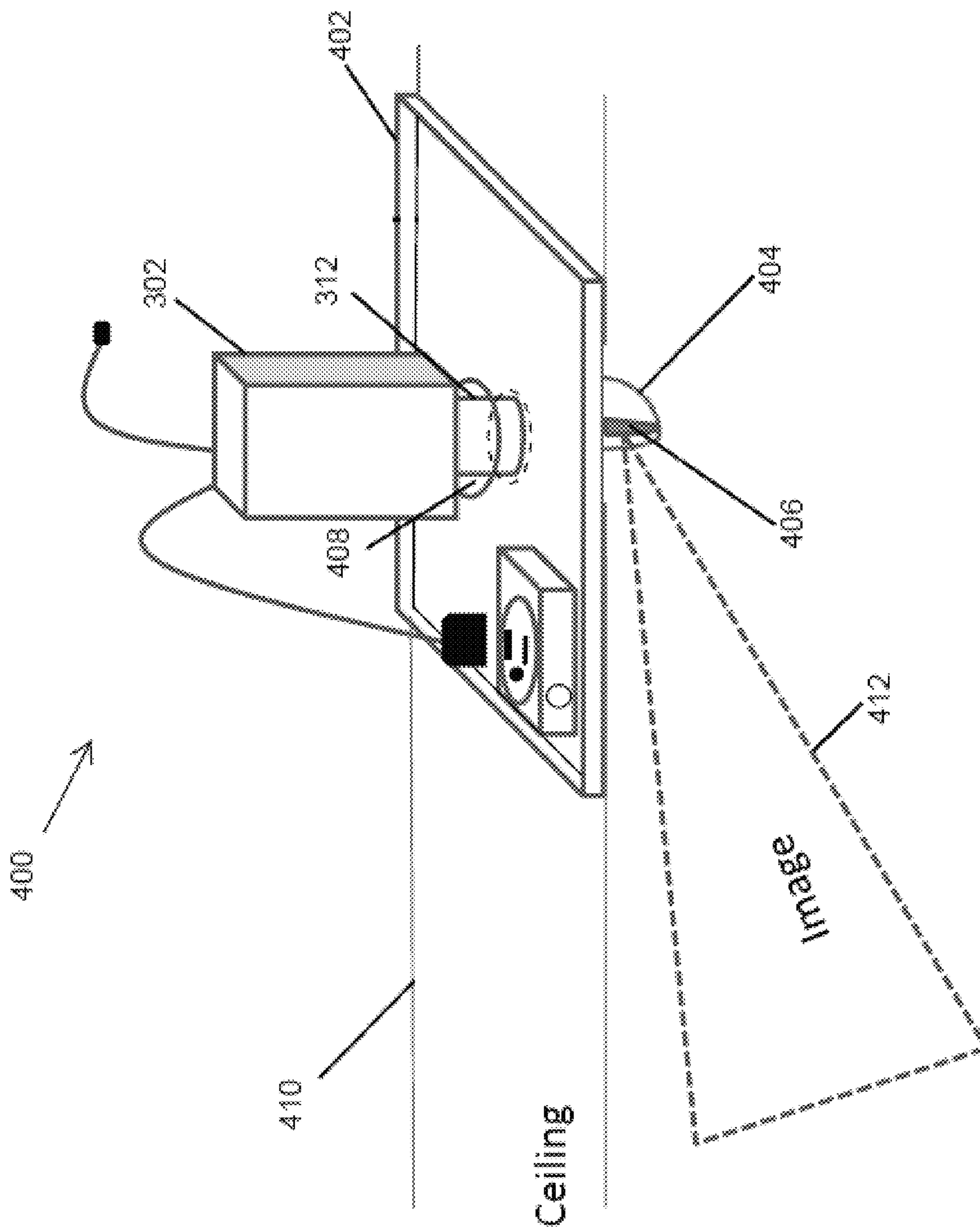


FIG. 4

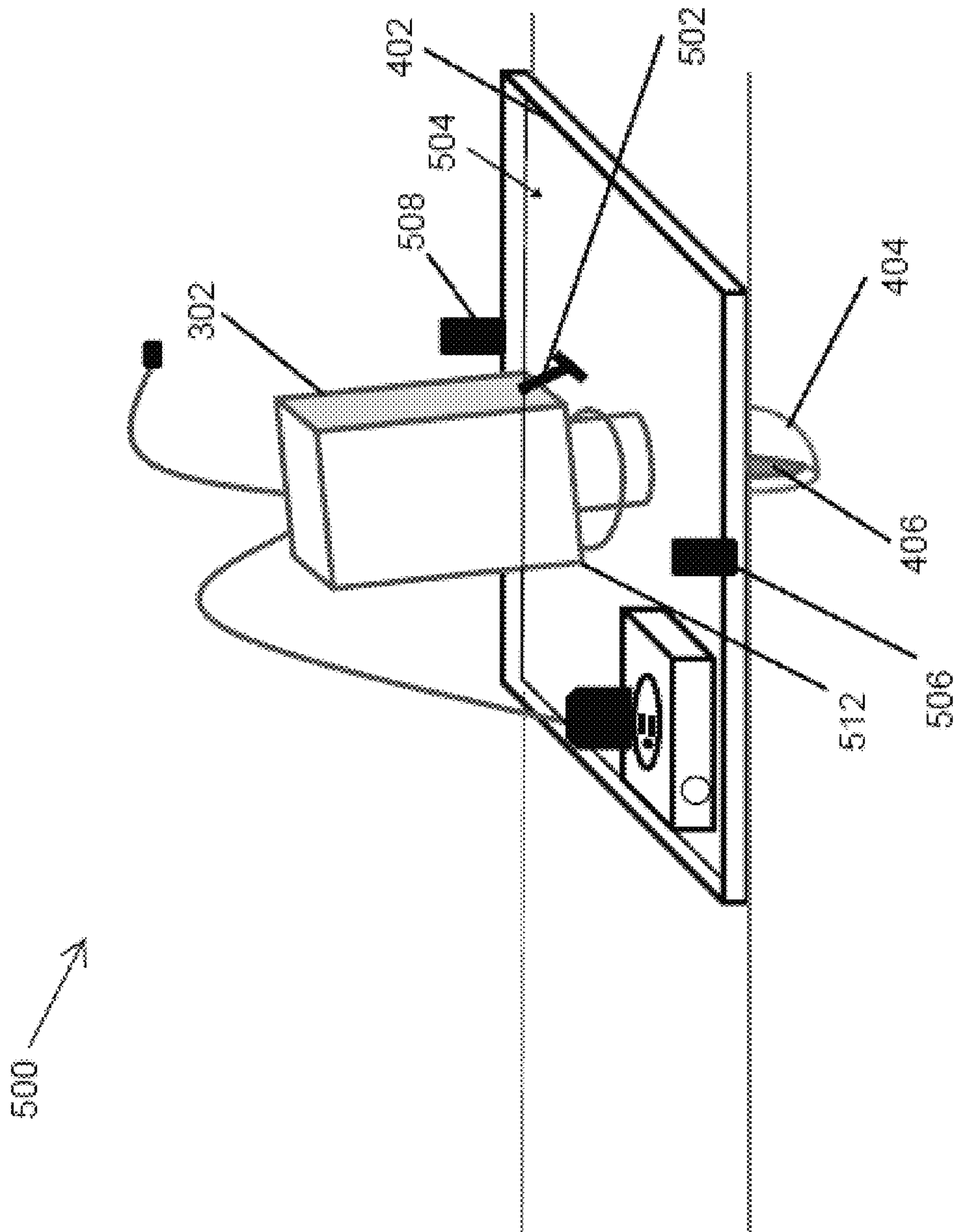


FIG. 5

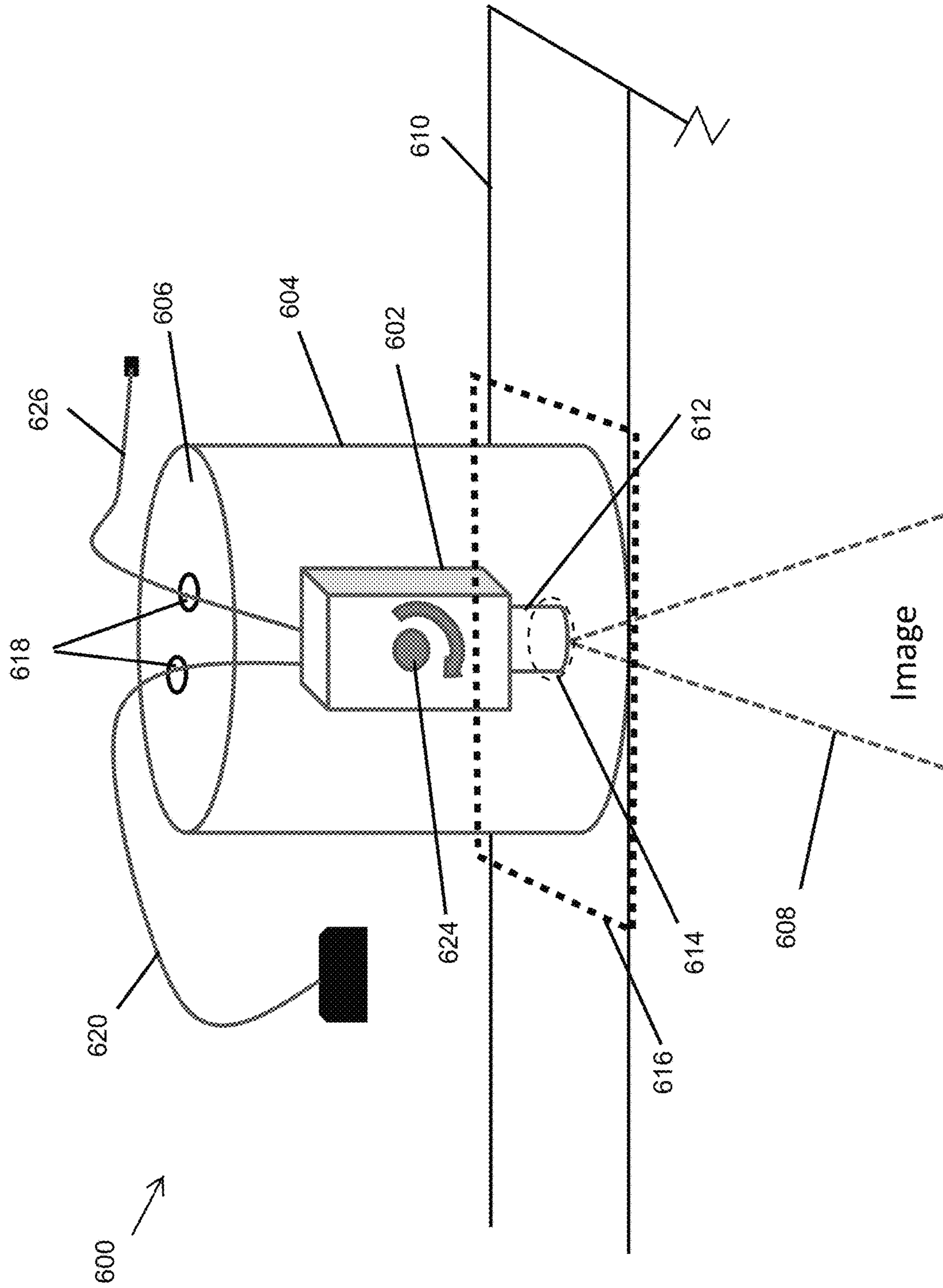


FIG. 6



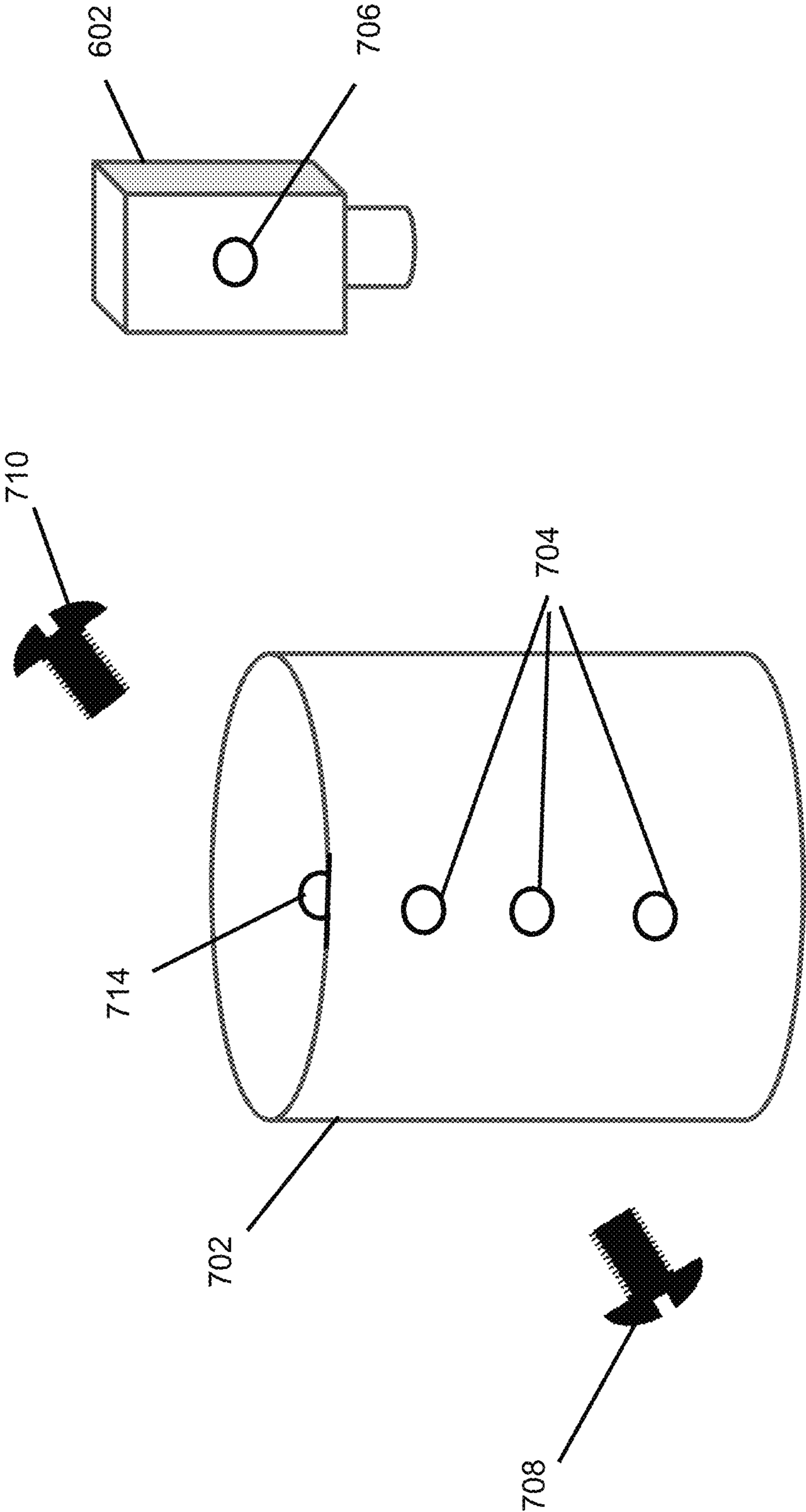


FIG. 7

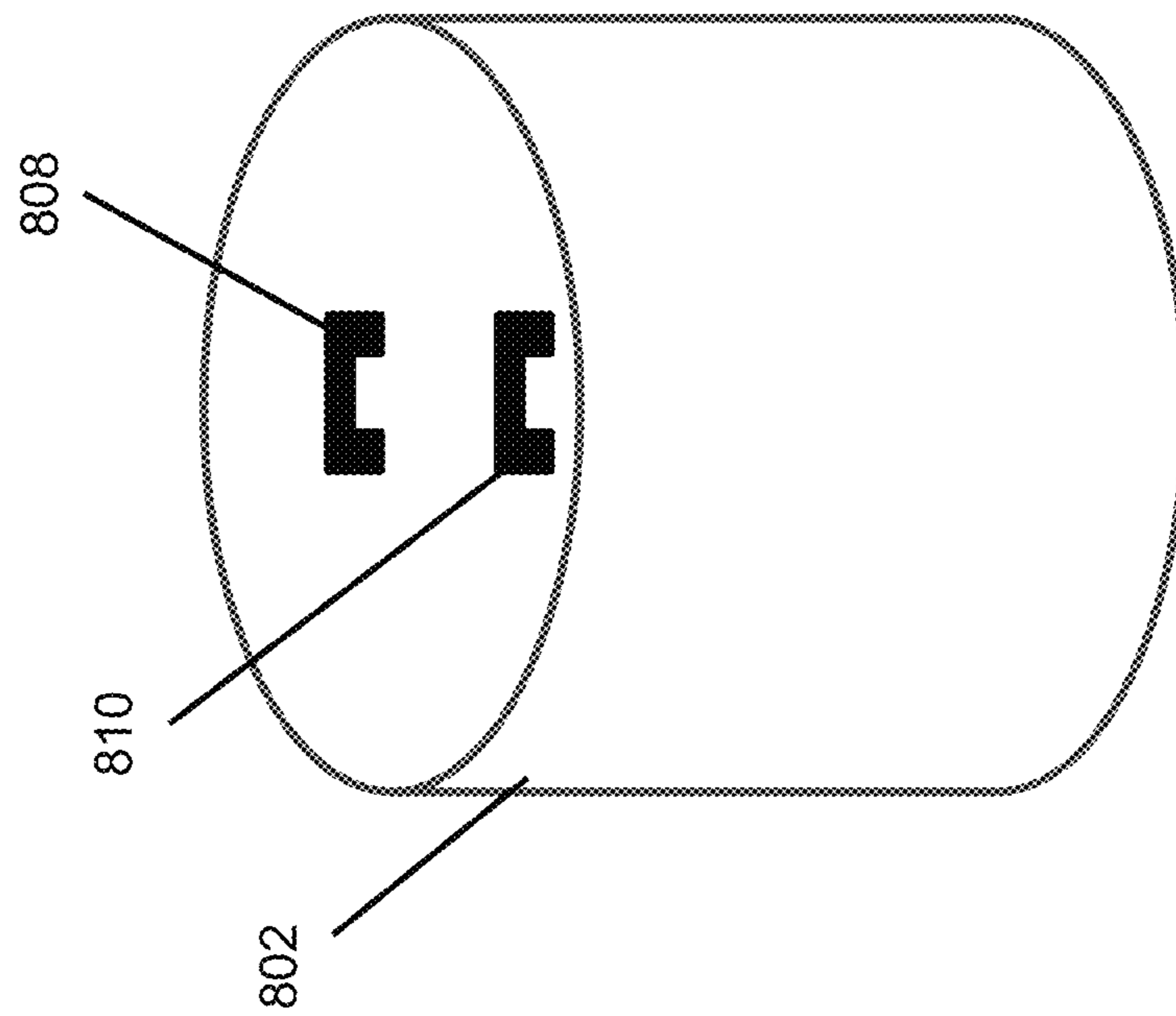
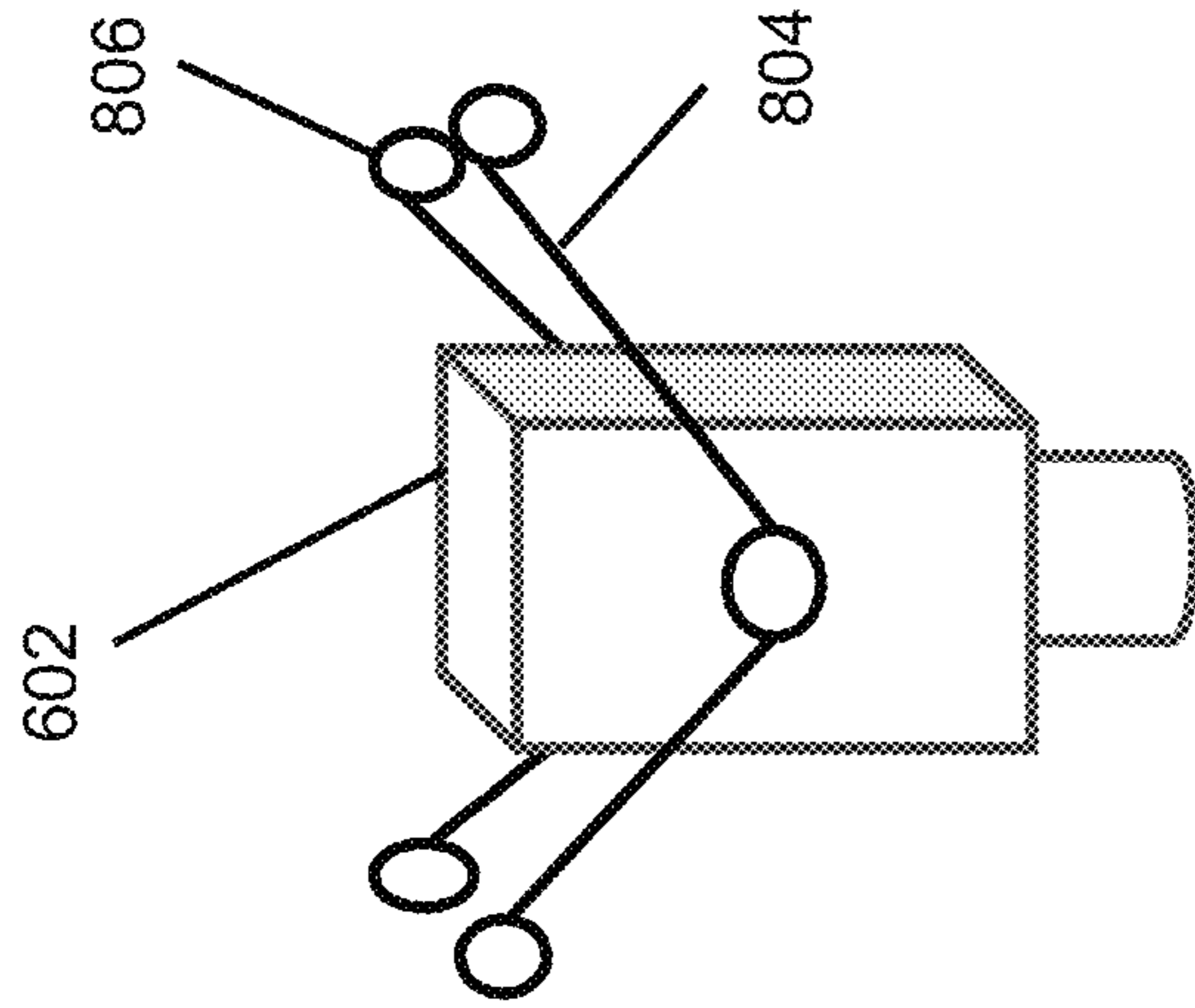


FIG. 8

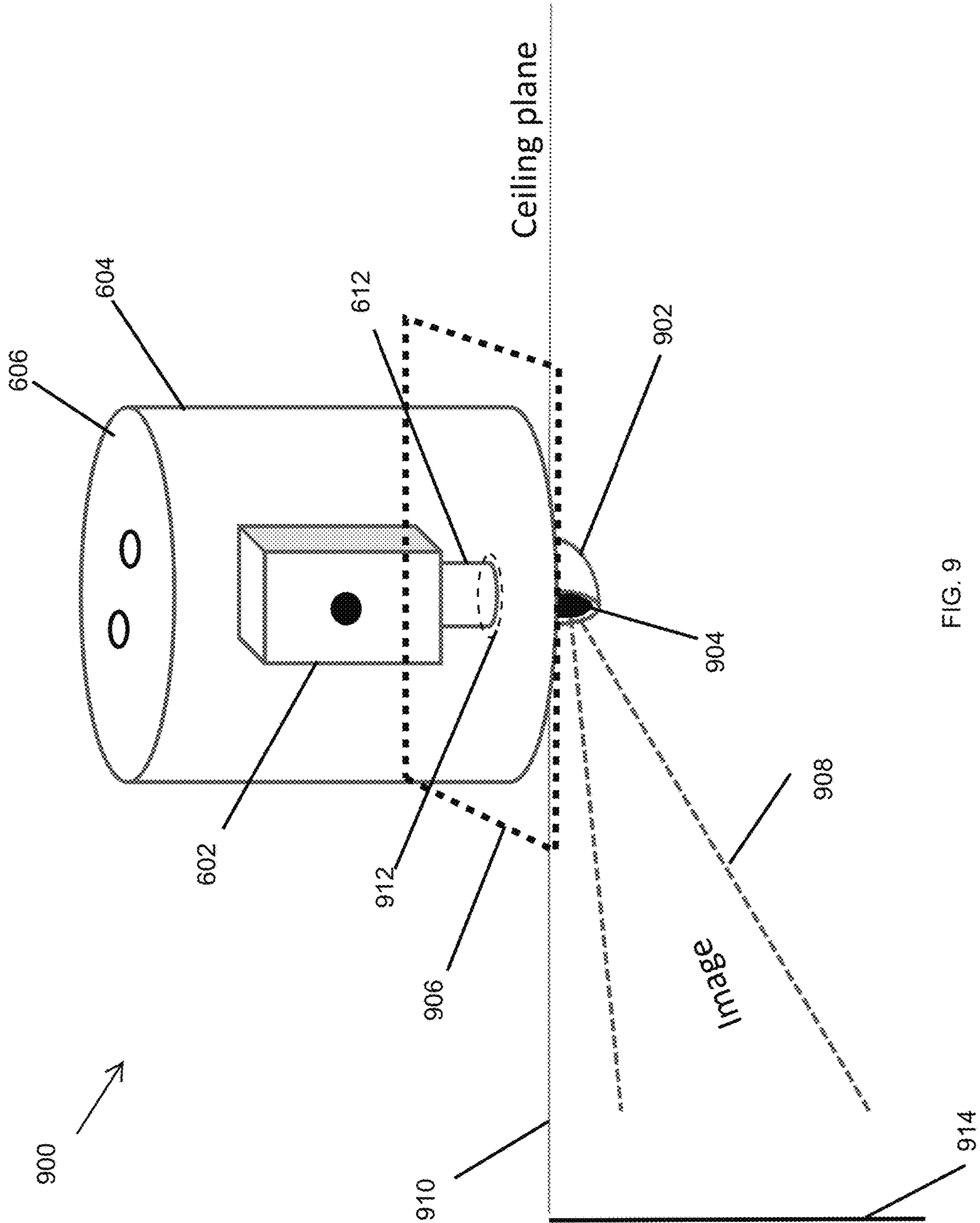


FIG. 9

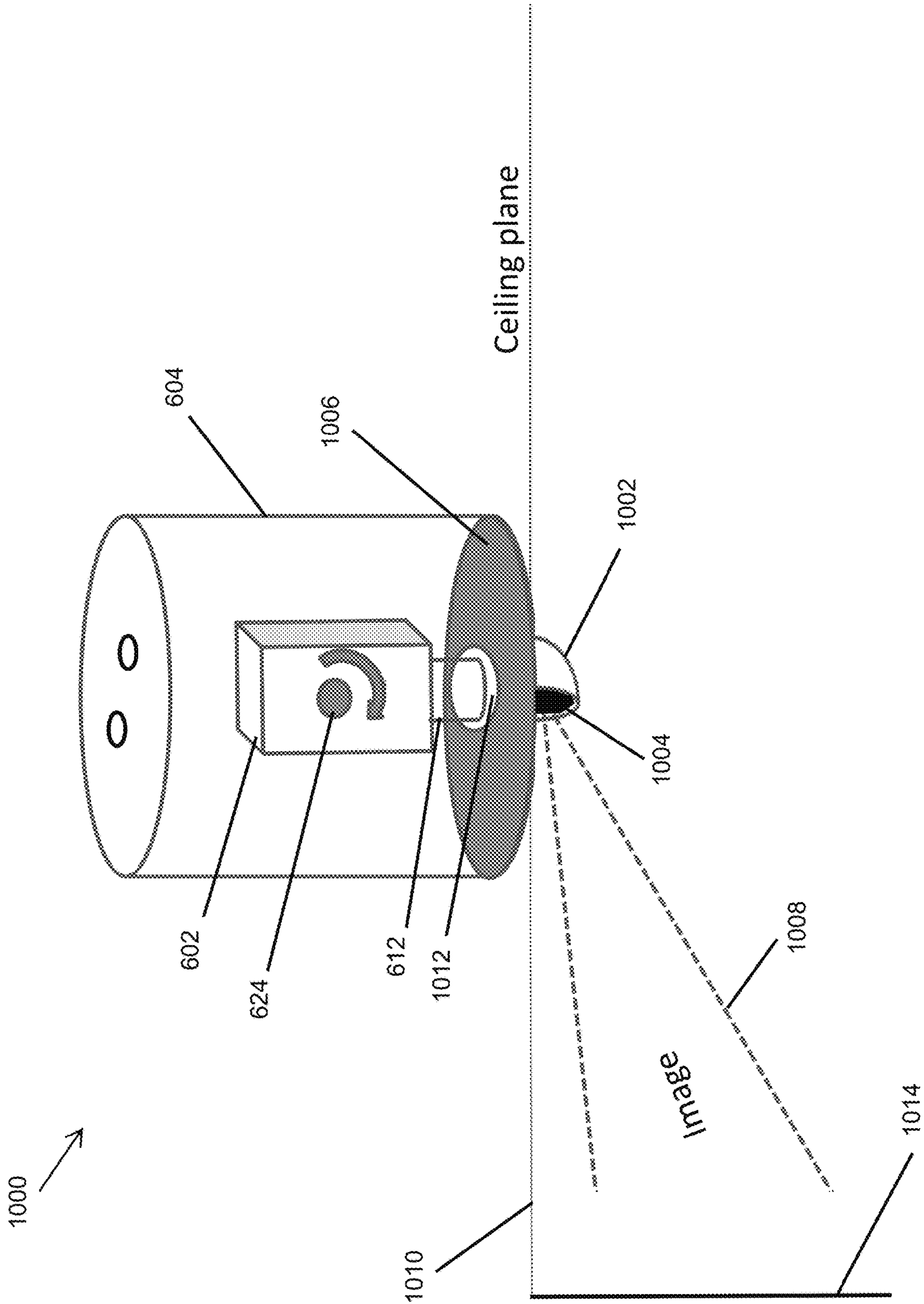


FIG. 10

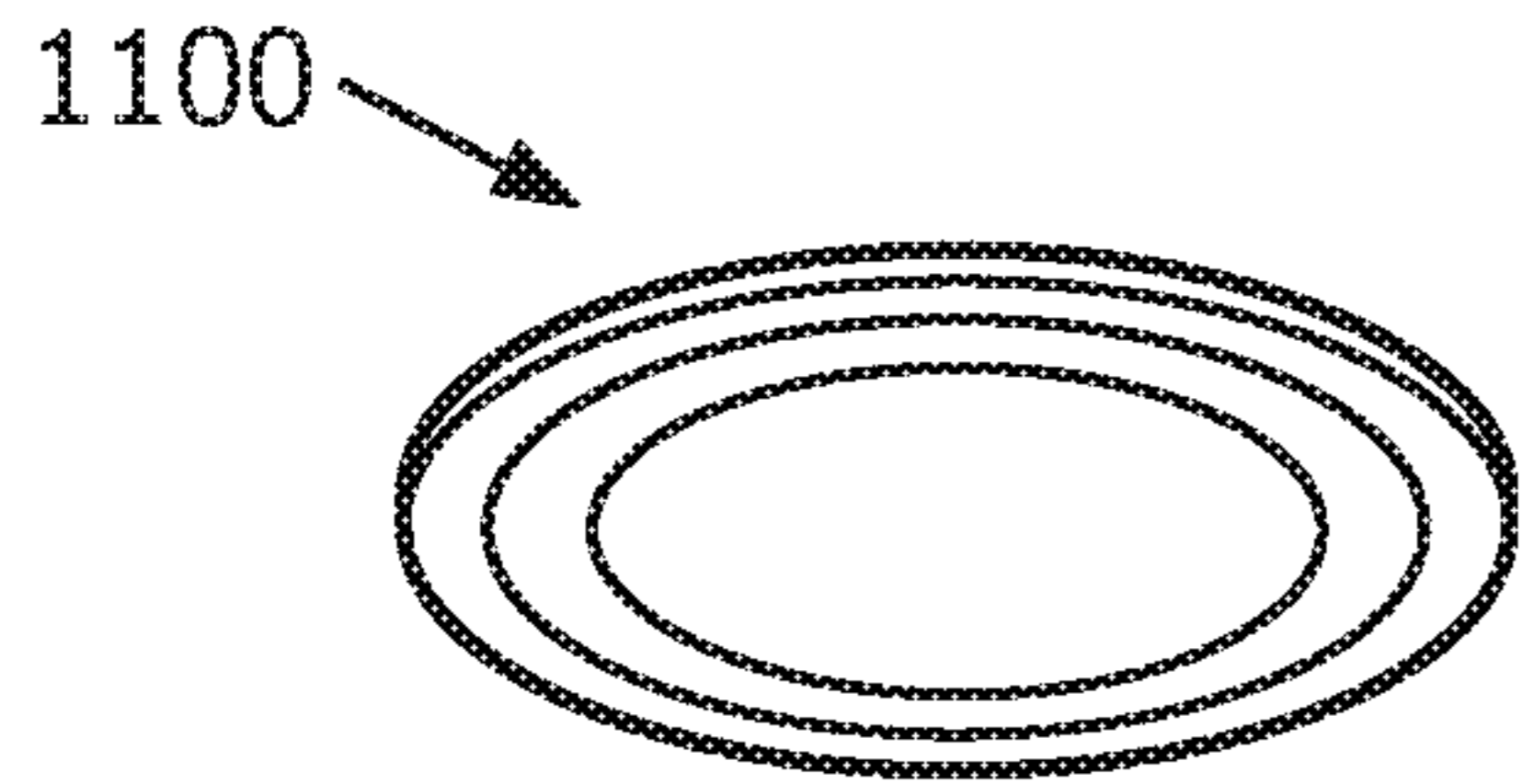


FIG. 11A

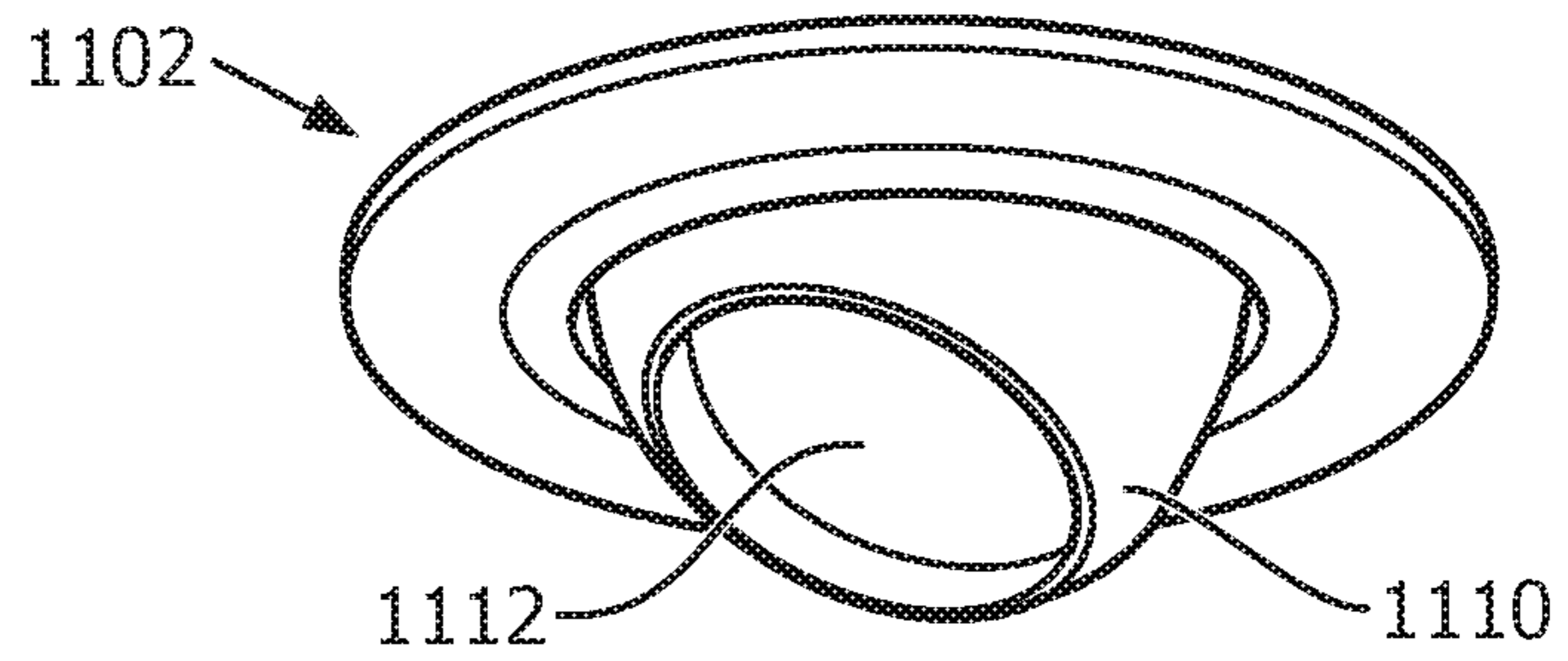


FIG. 11B

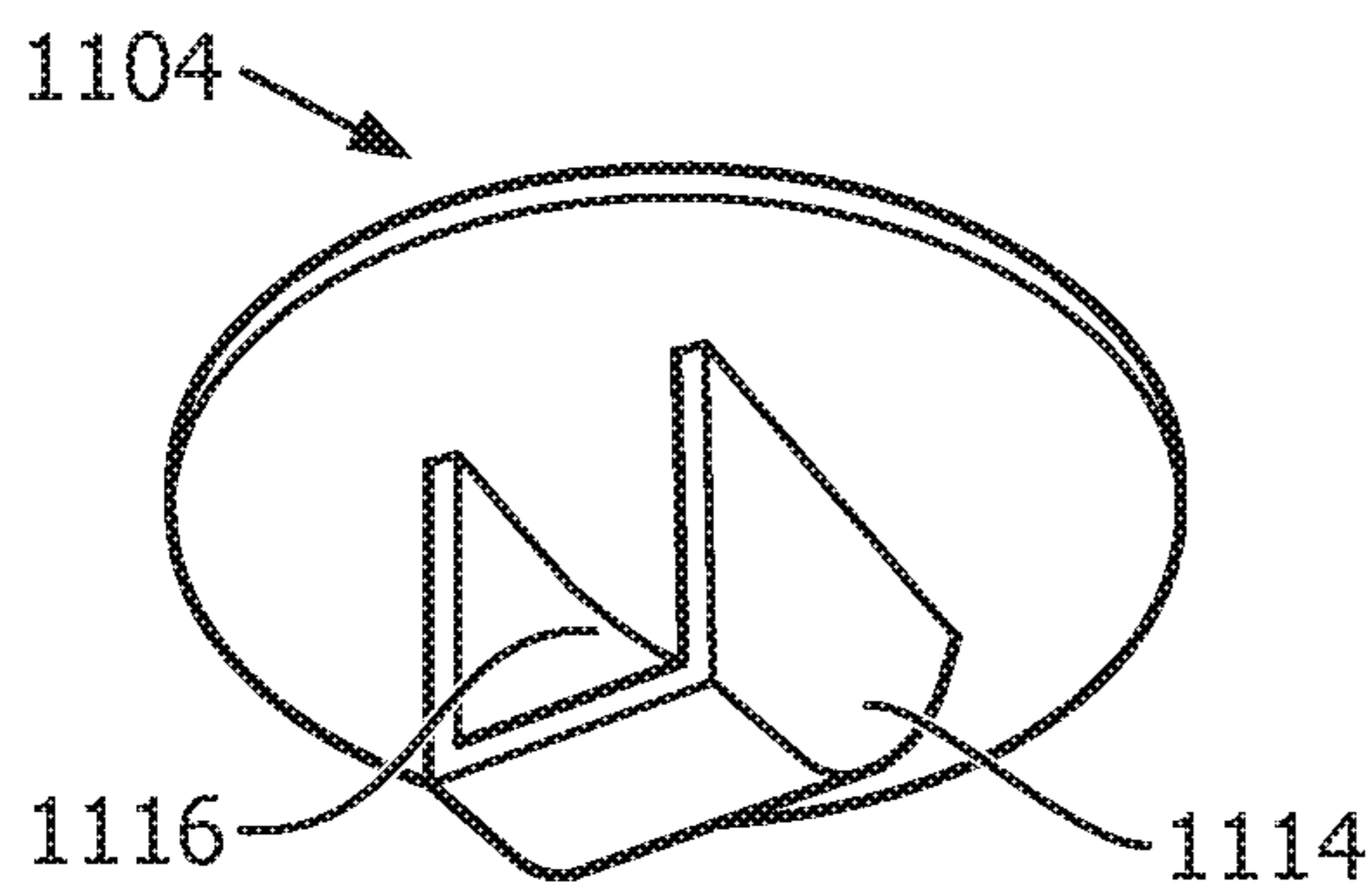


FIG. 11C

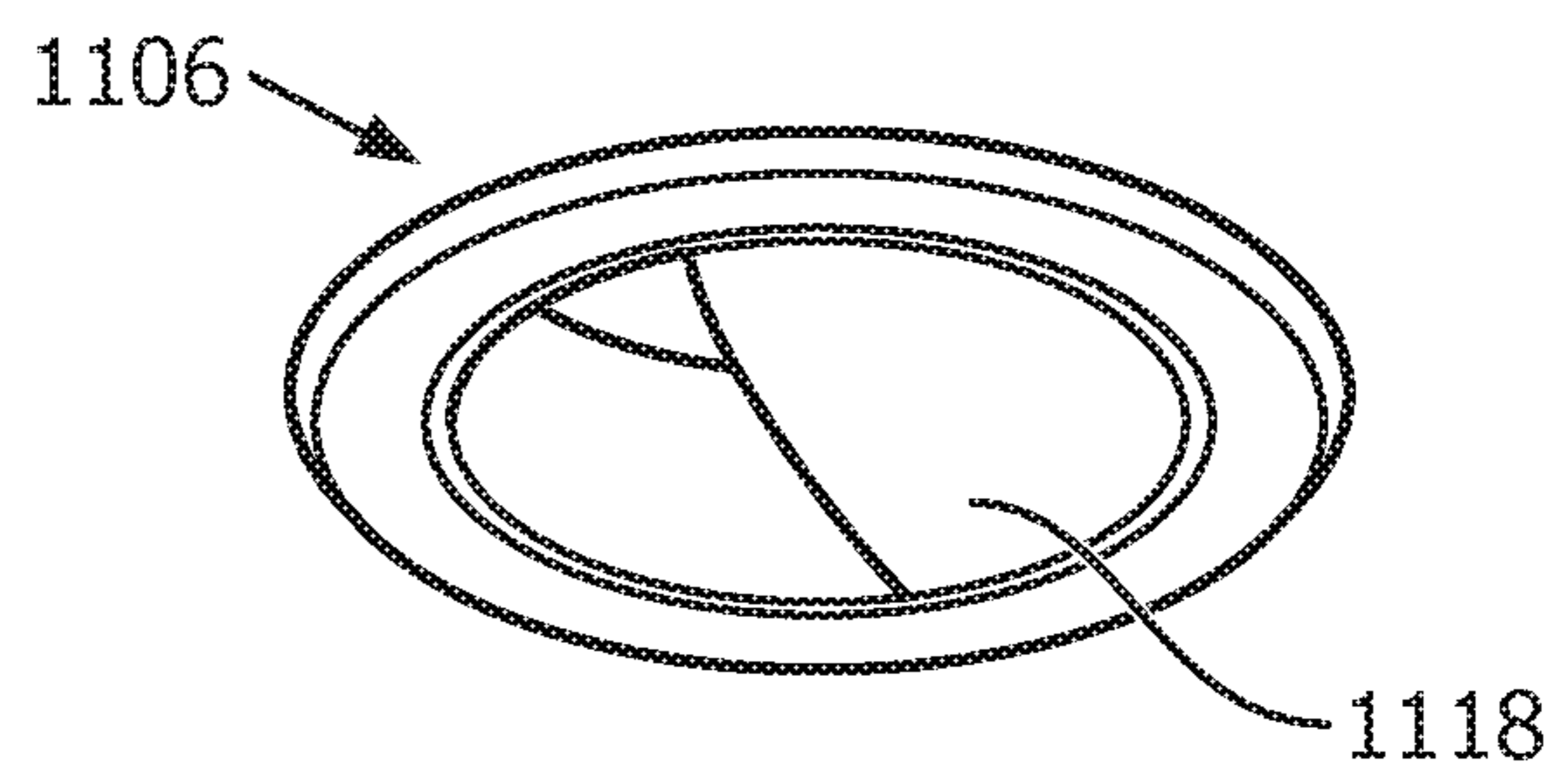


FIG. 11D

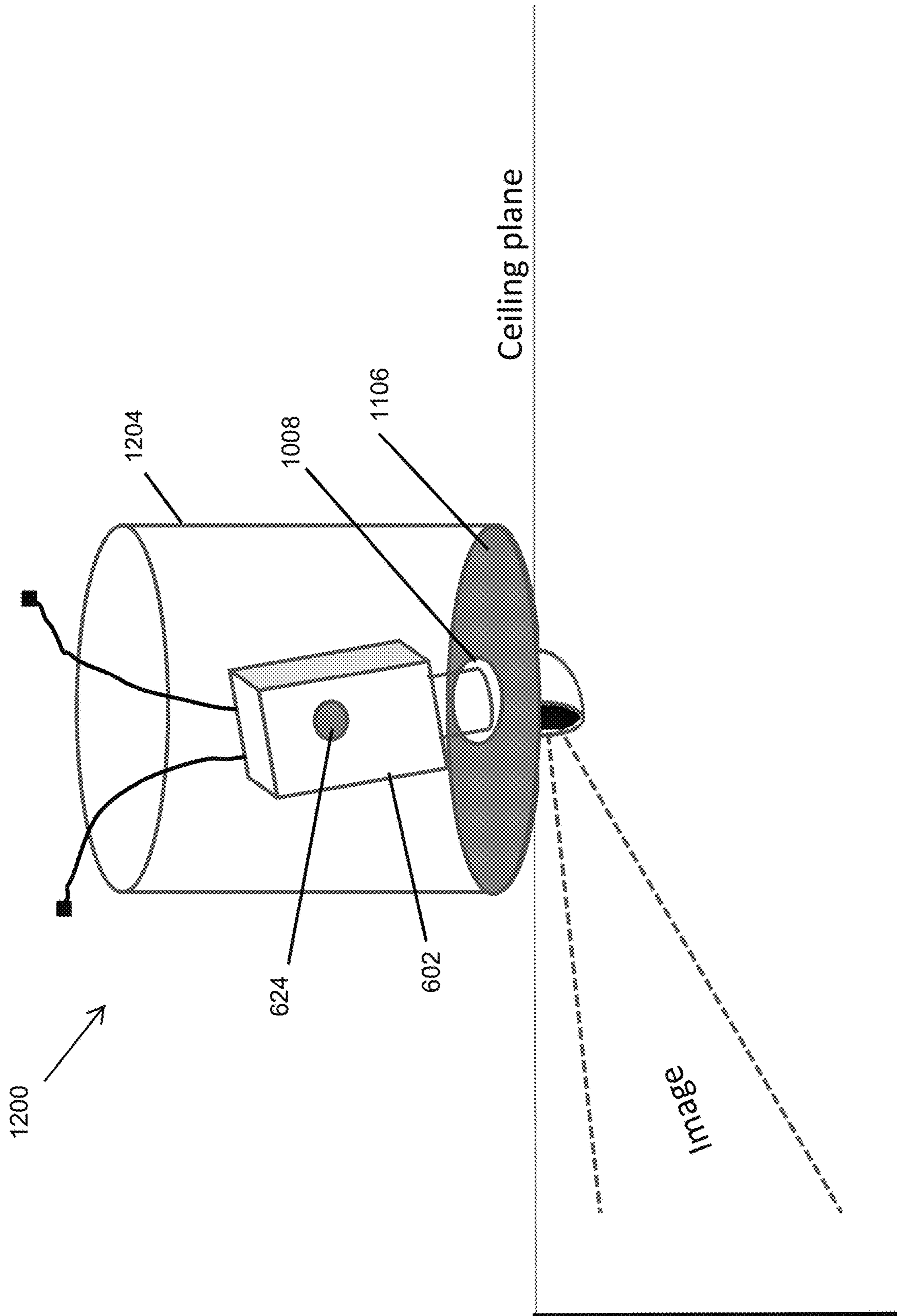


FIG. 12

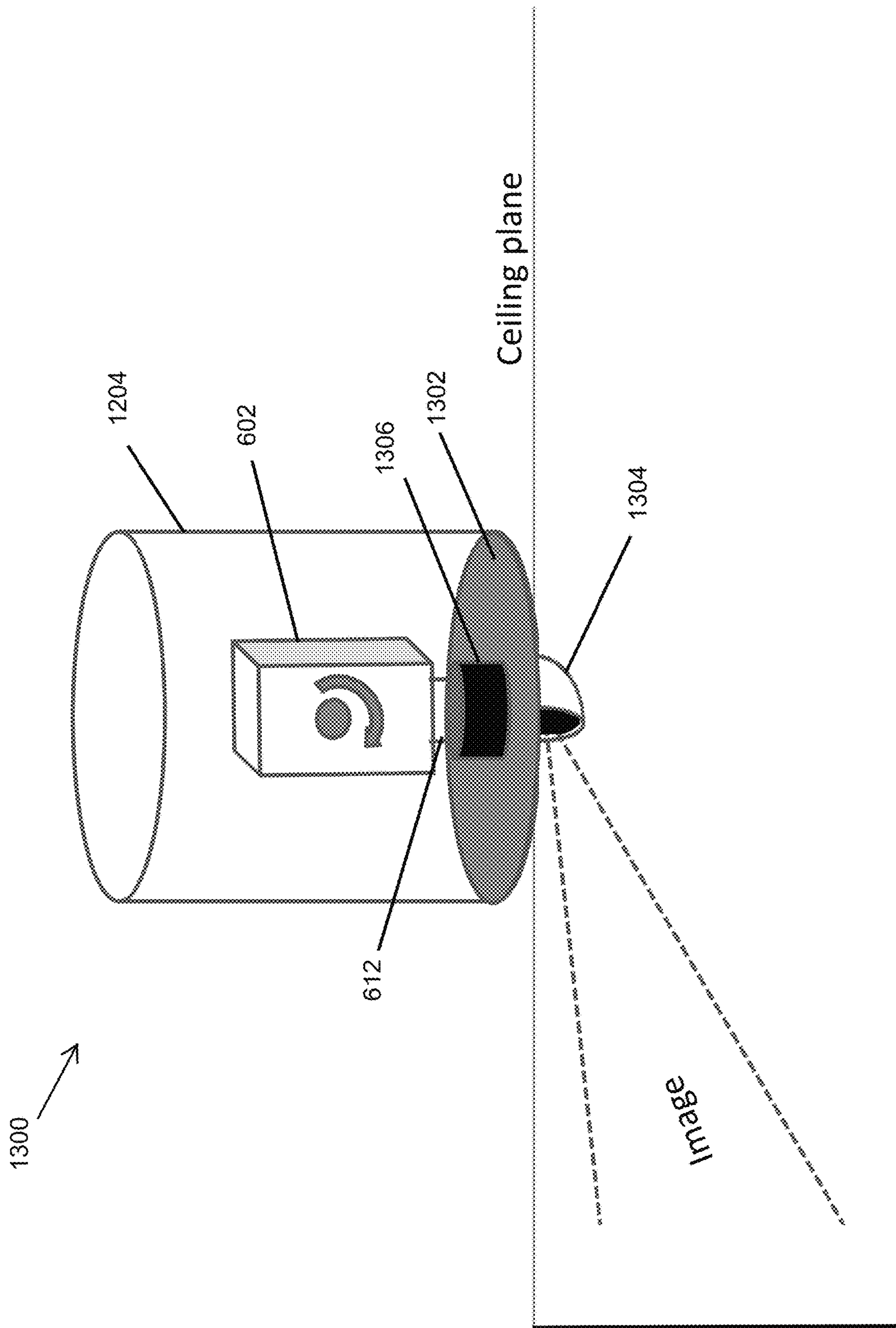


FIG. 13

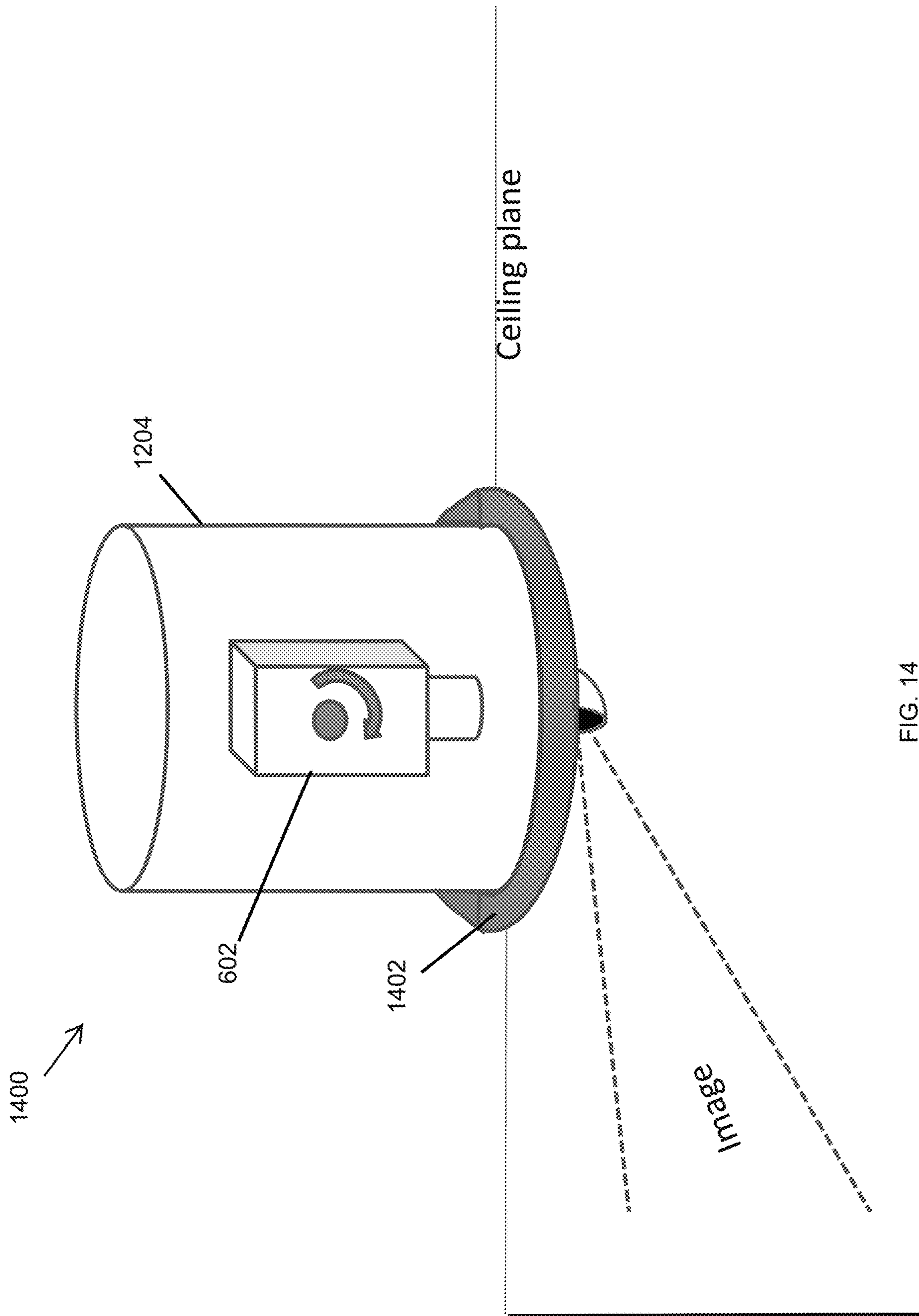


FIG. 14



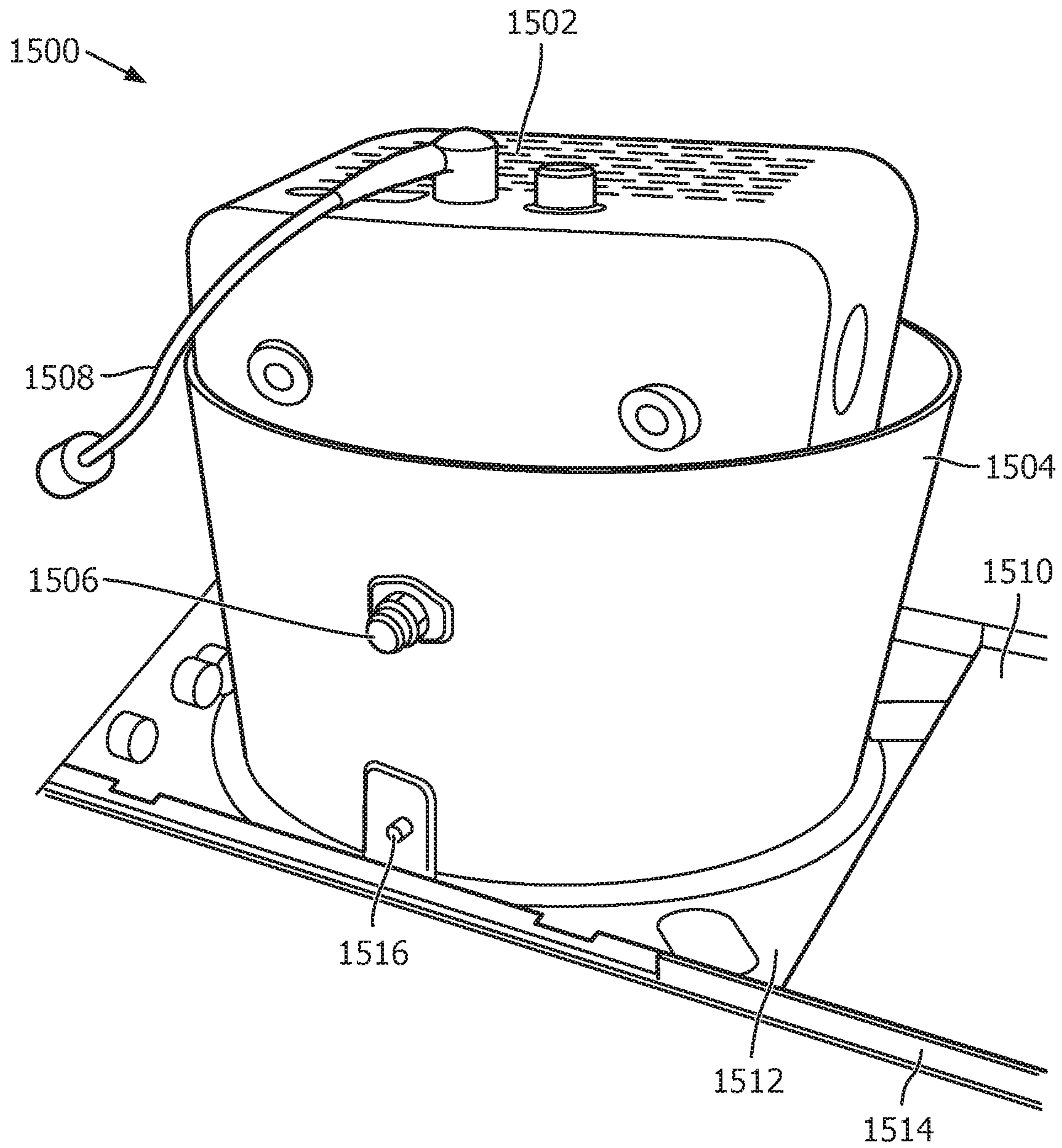


FIG. 15A

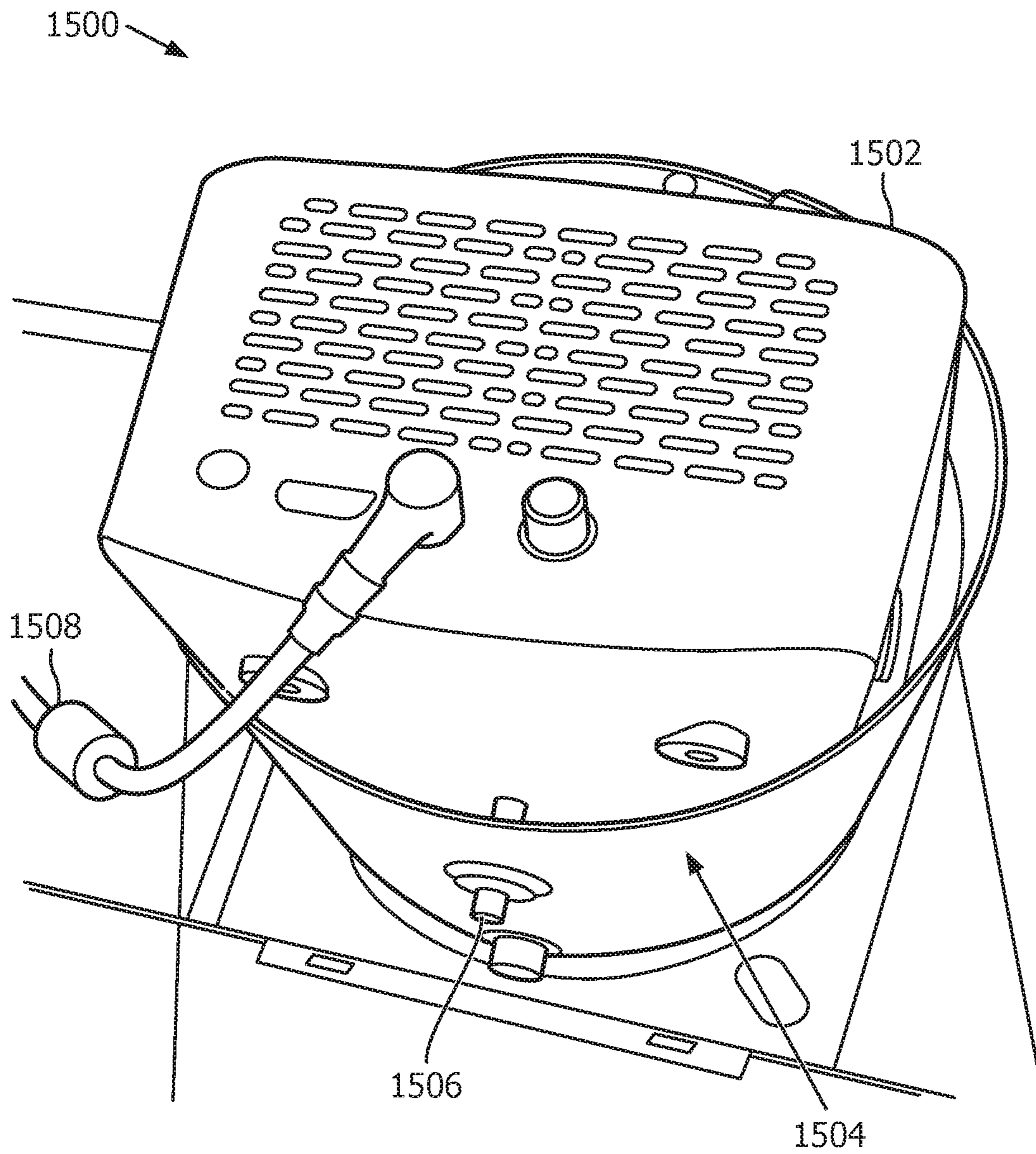


FIG. 15B

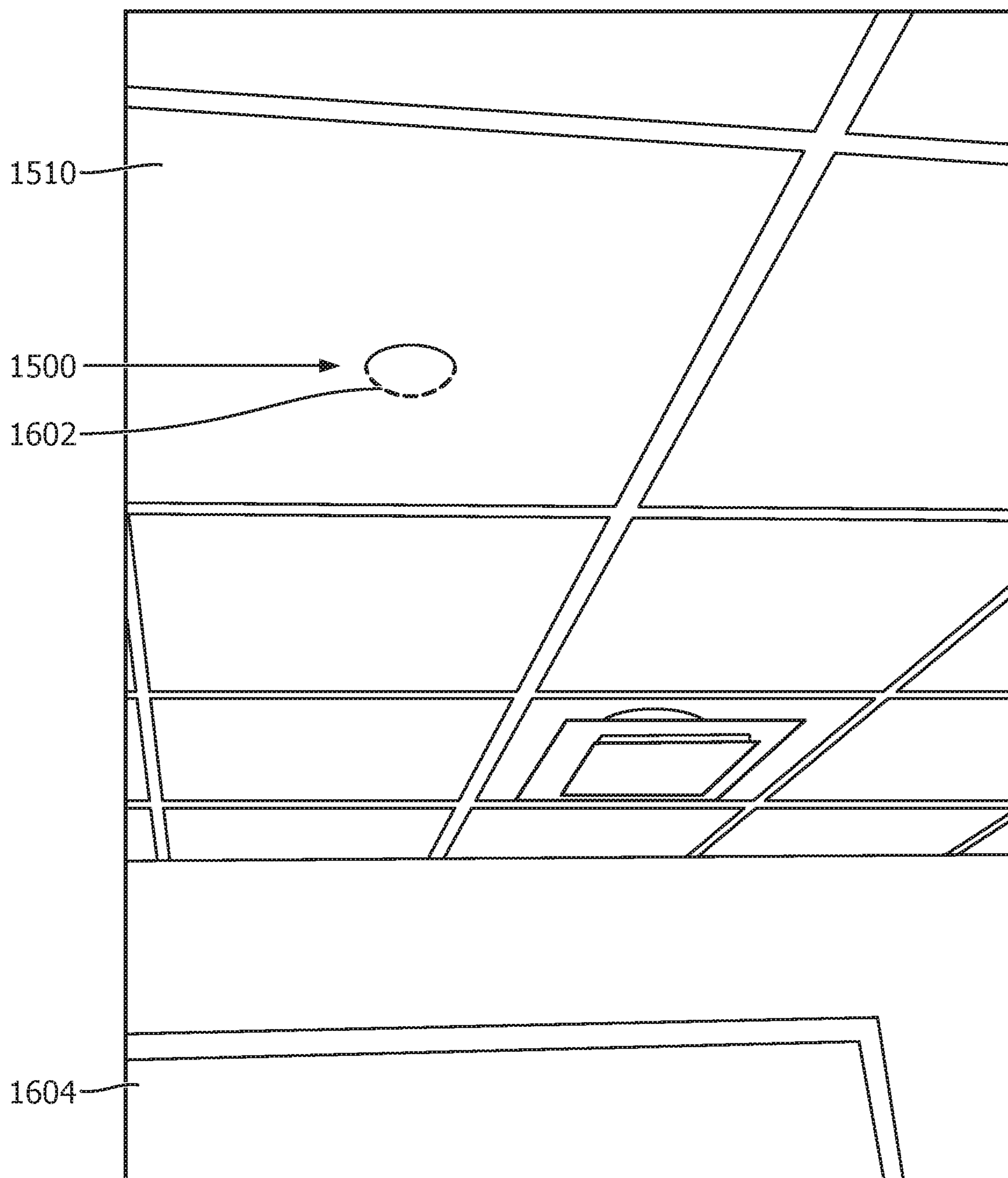


FIG. 16

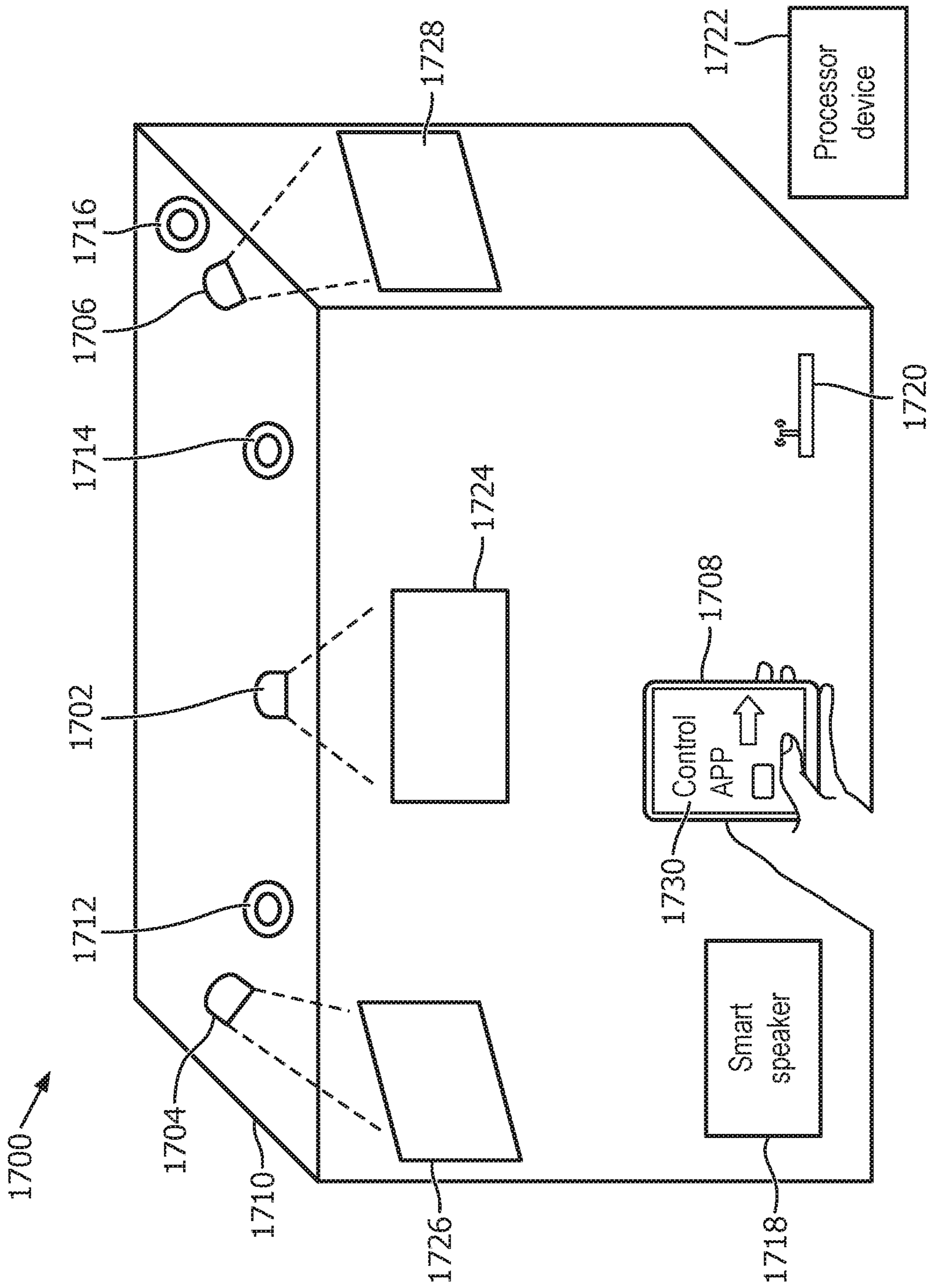


FIG. 17

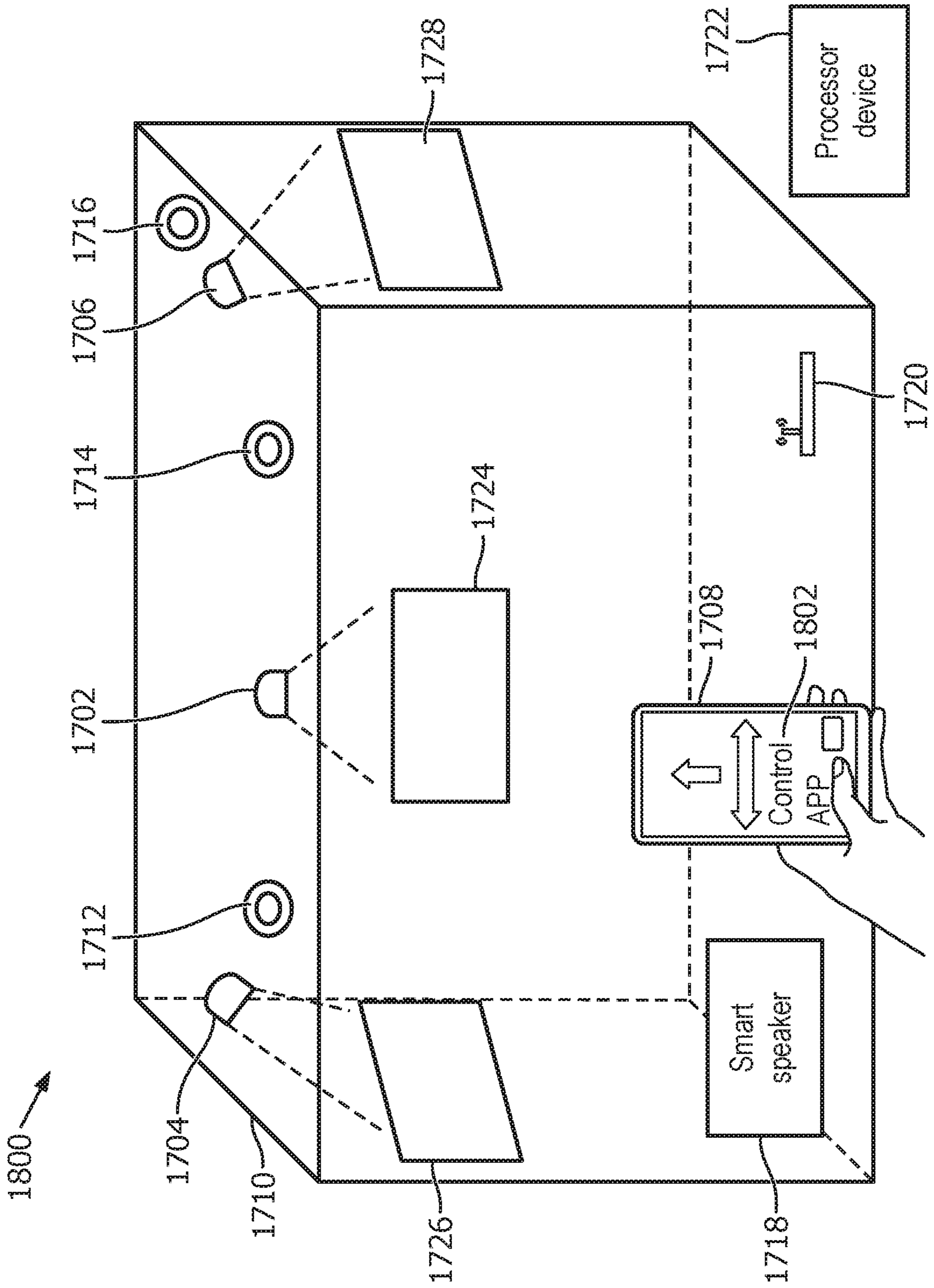


FIG. 18

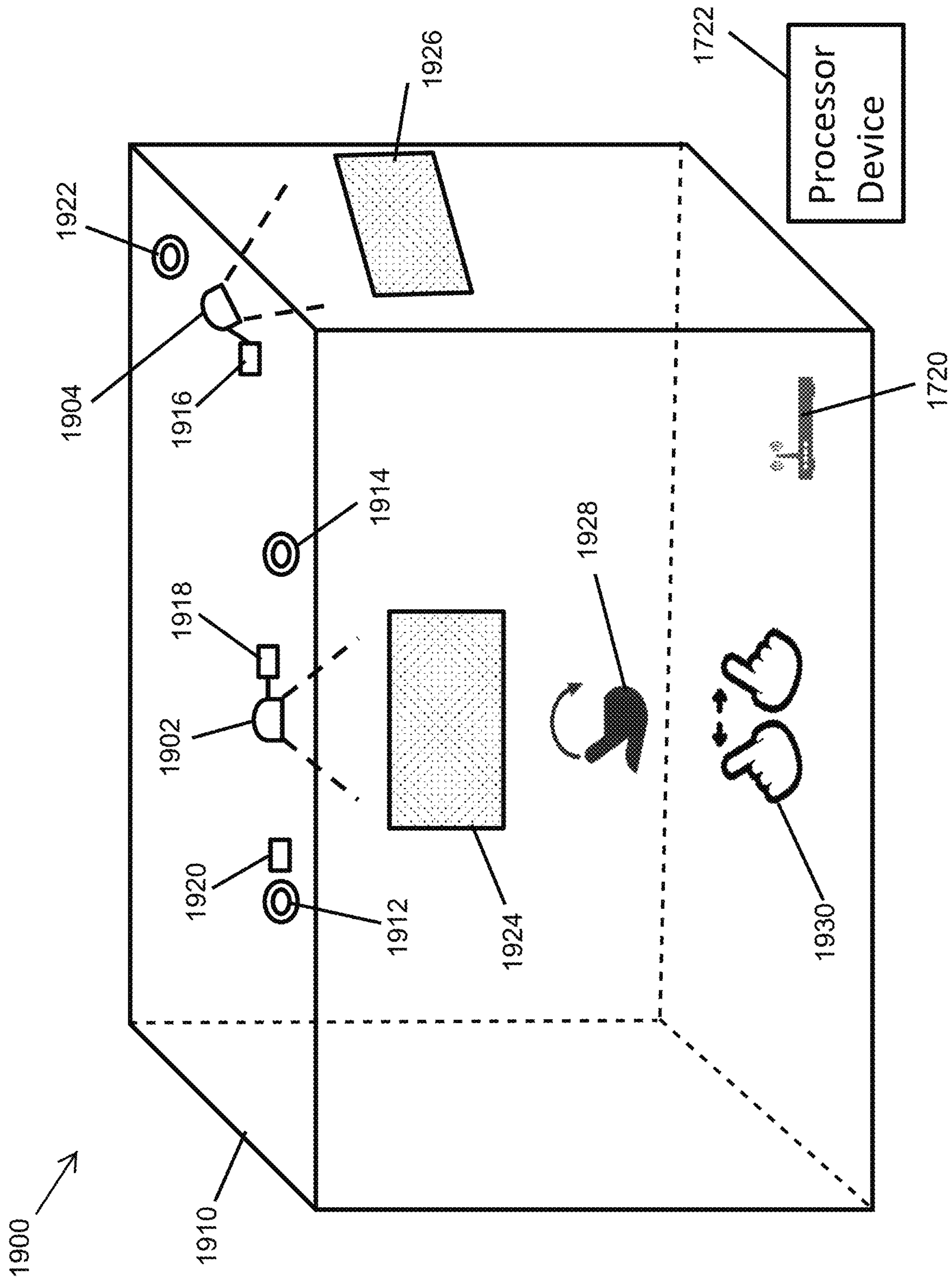


FIG. 19

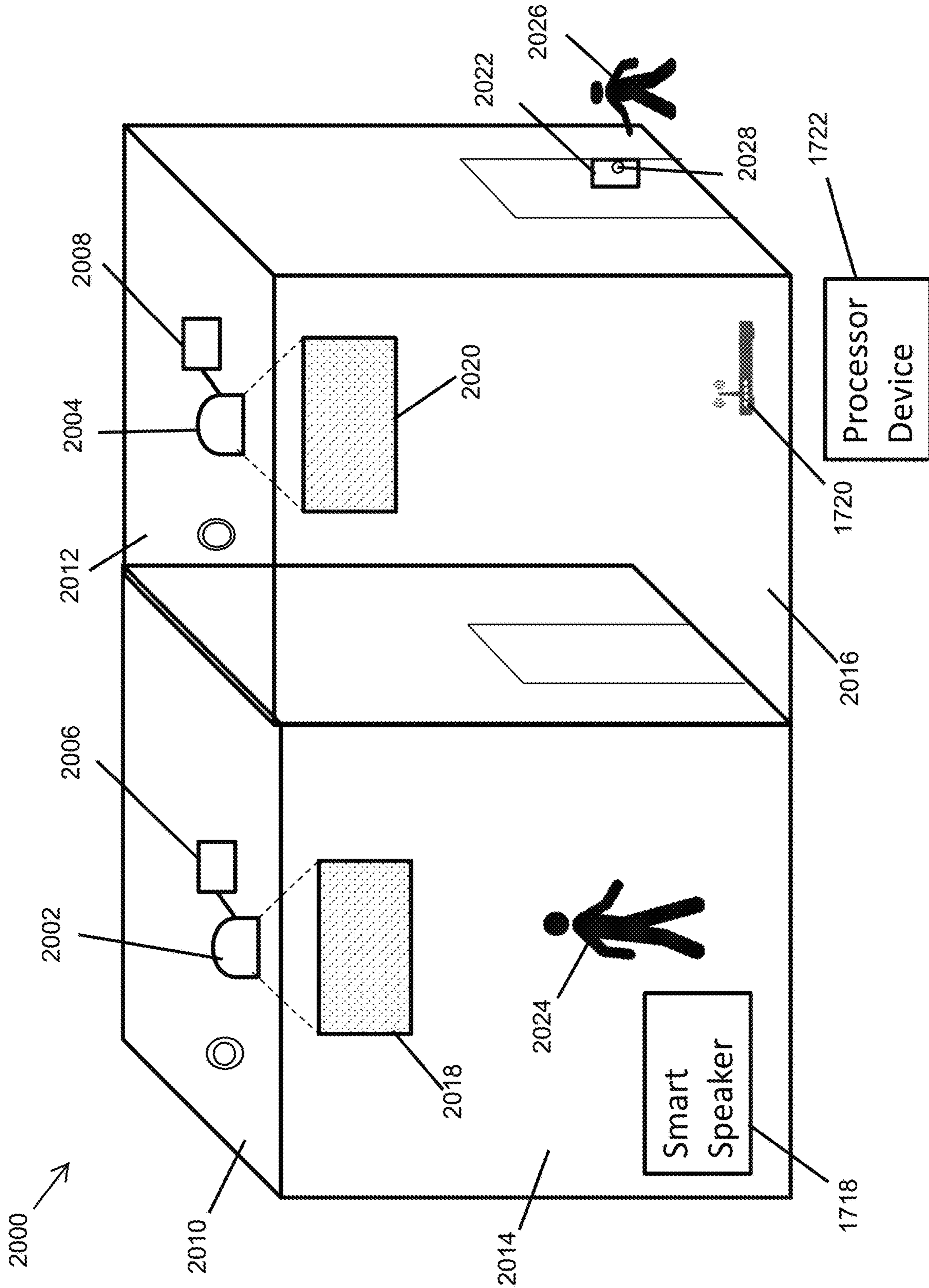


FIG. 20

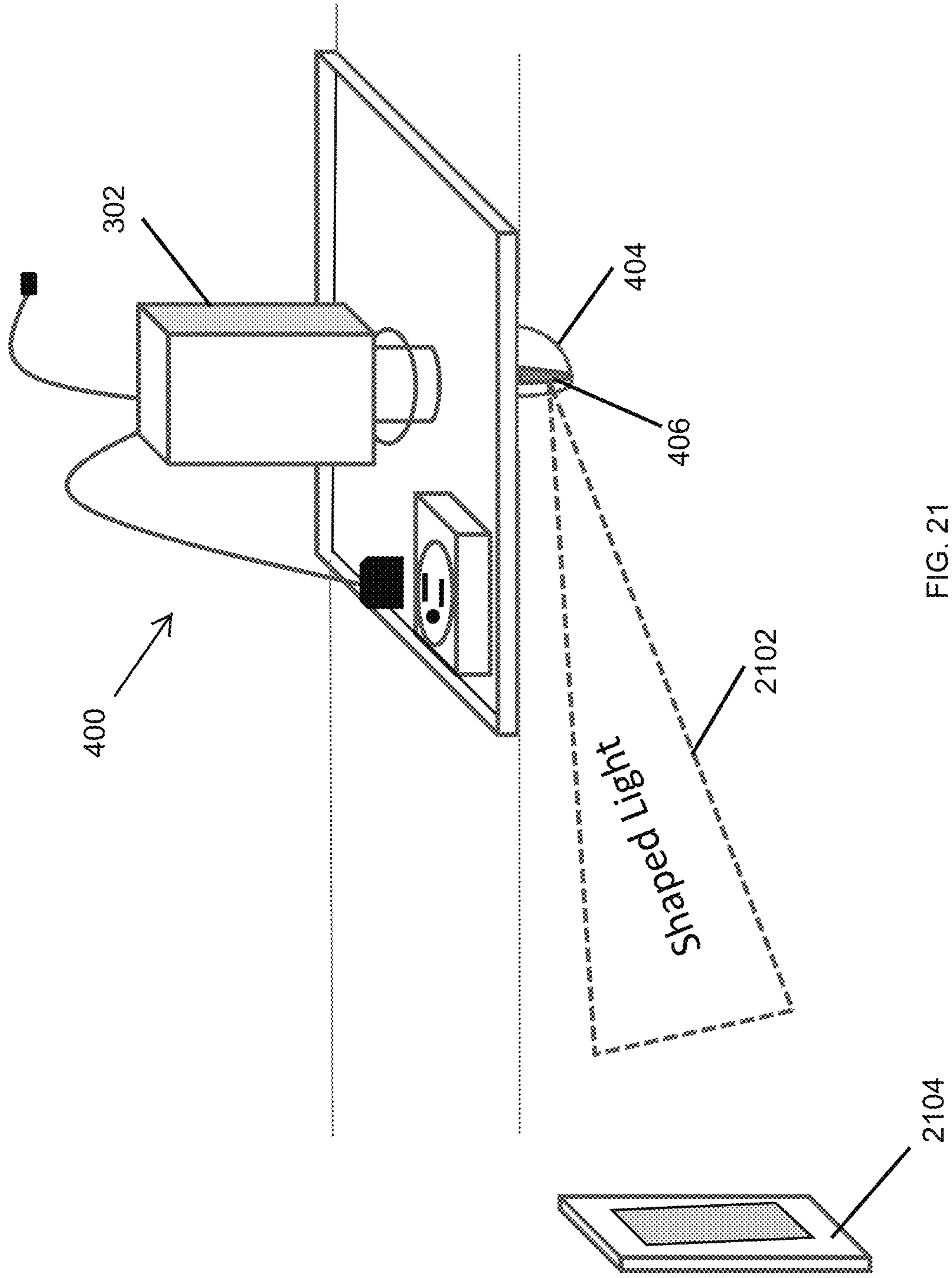


FIG. 21



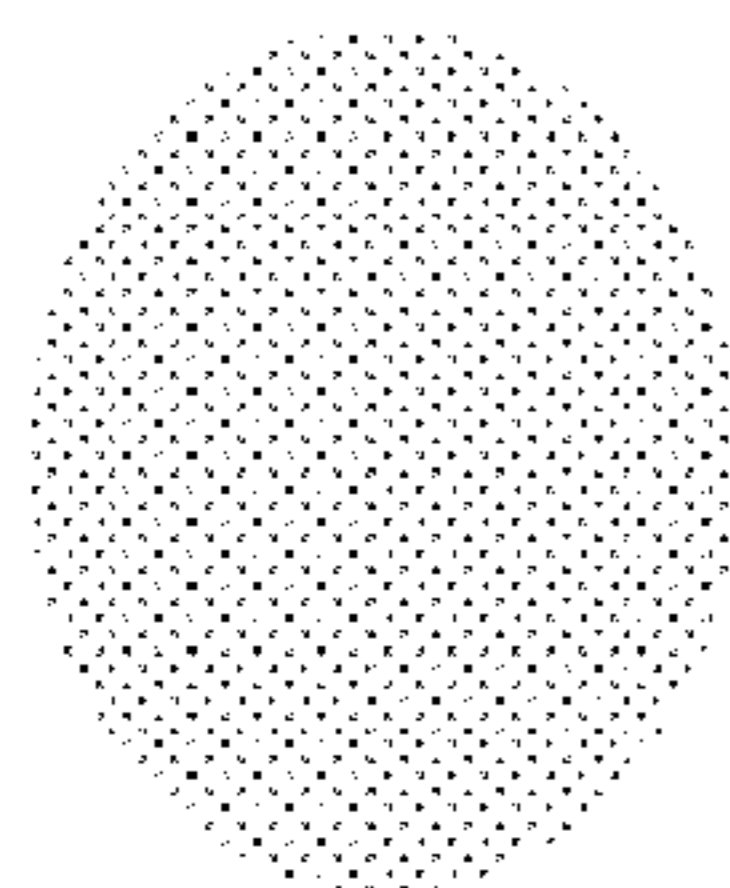


FIG. 22A

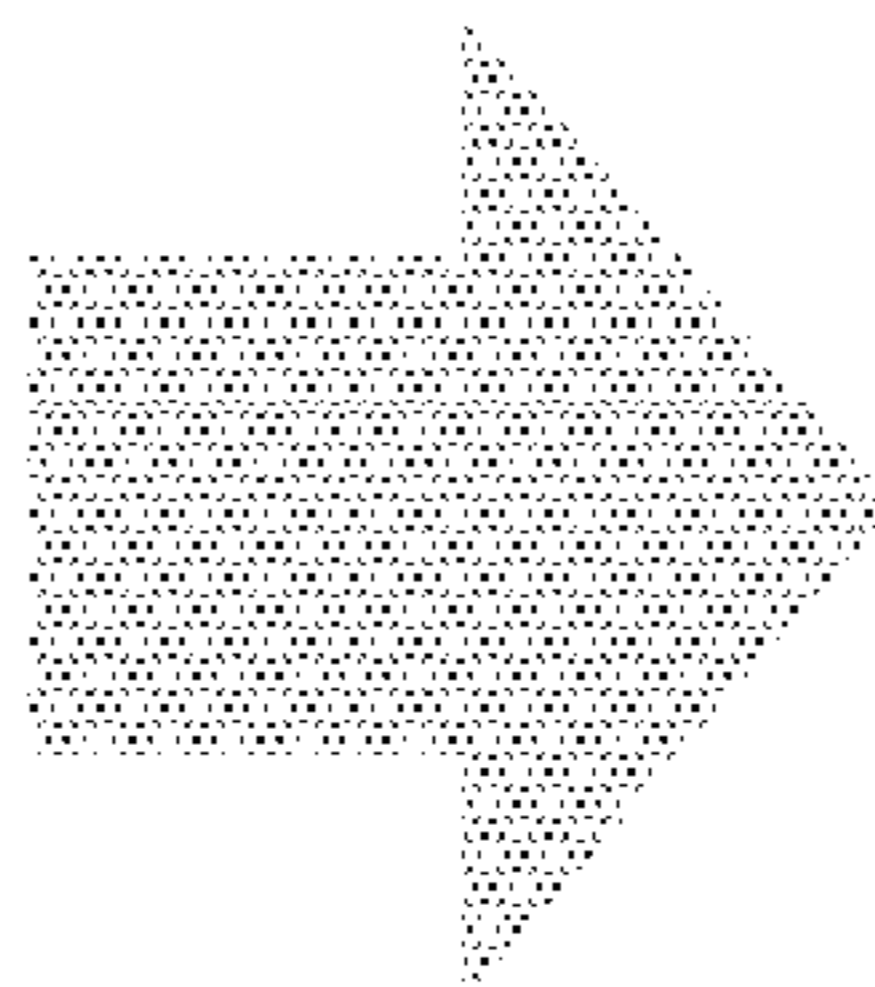


FIG. 22B

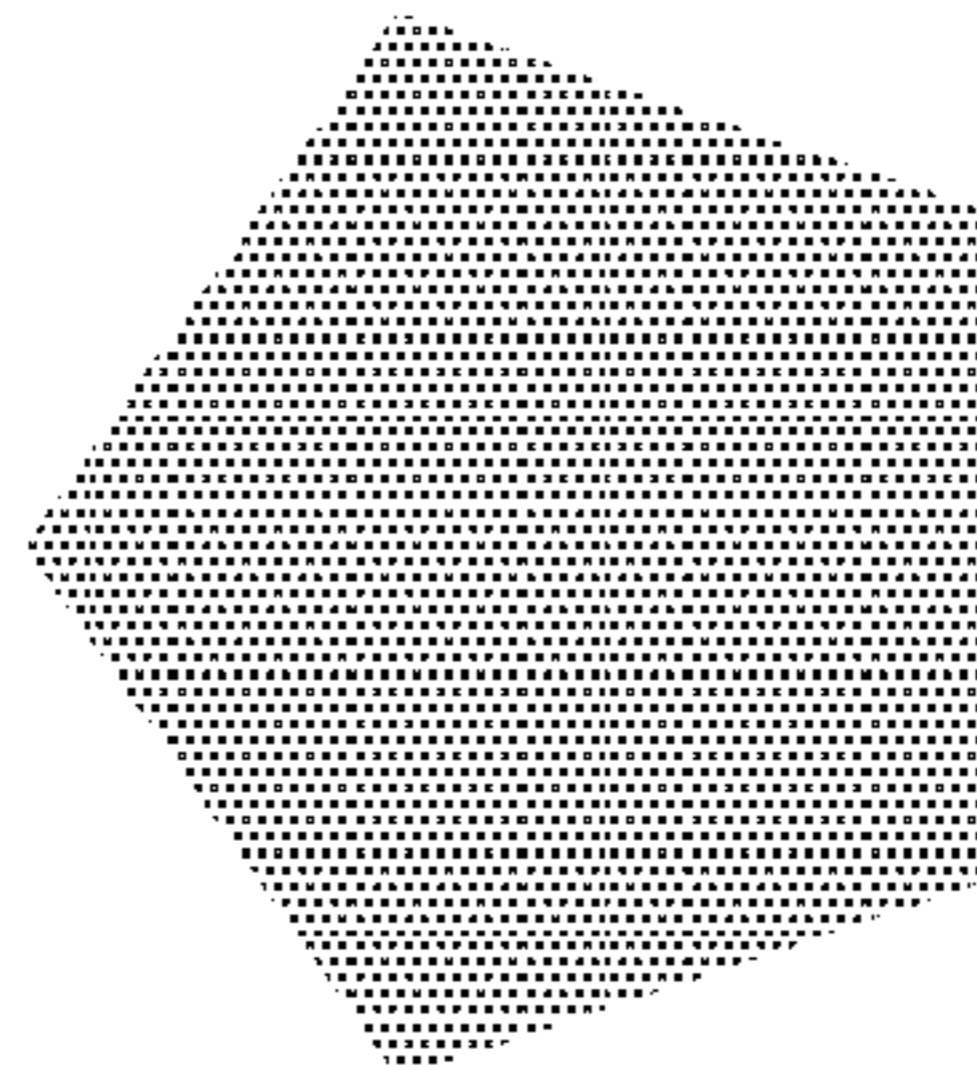


FIG. 22C

FIG. 22F

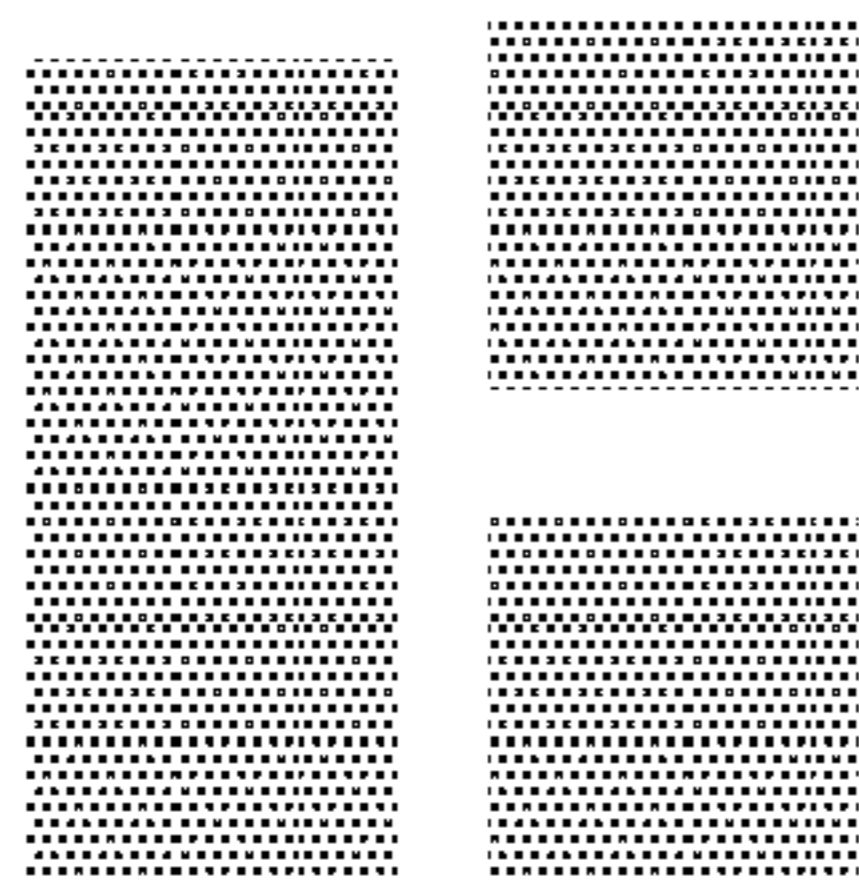


FIG. 22D

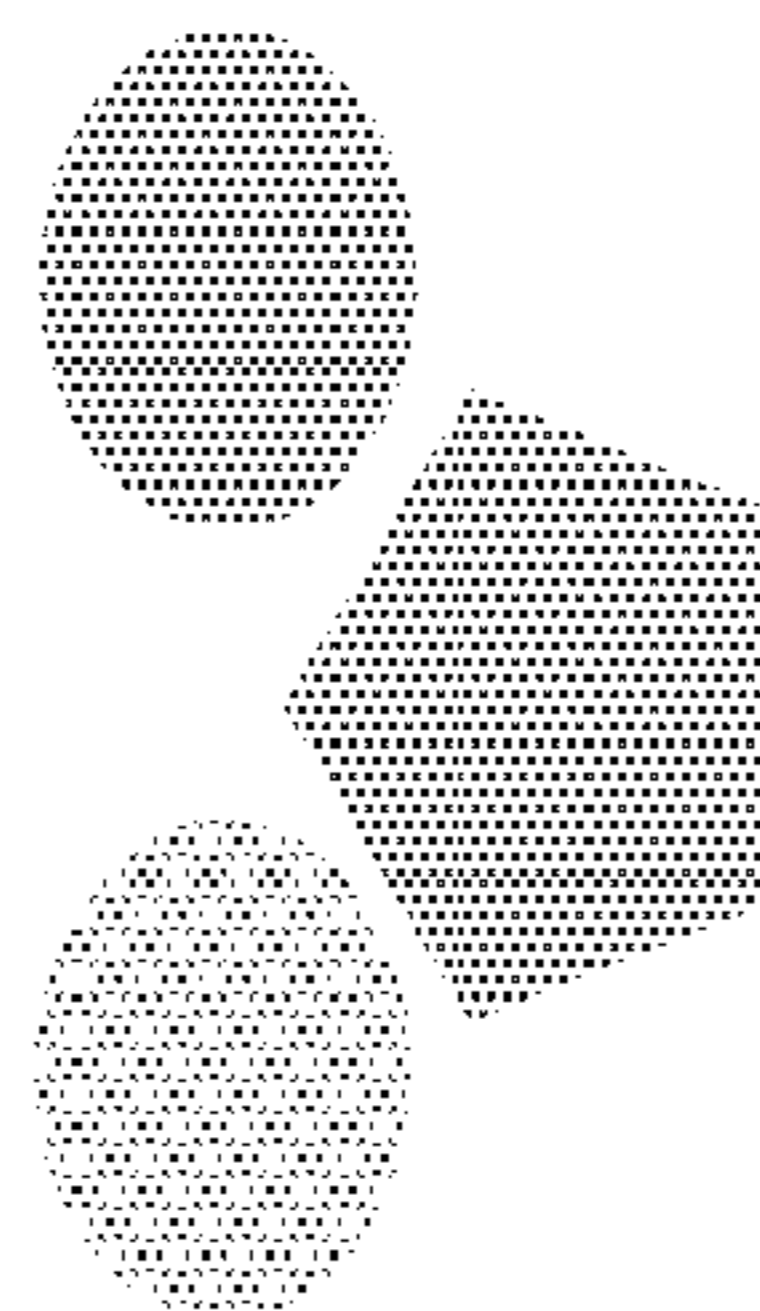


FIG. 22E

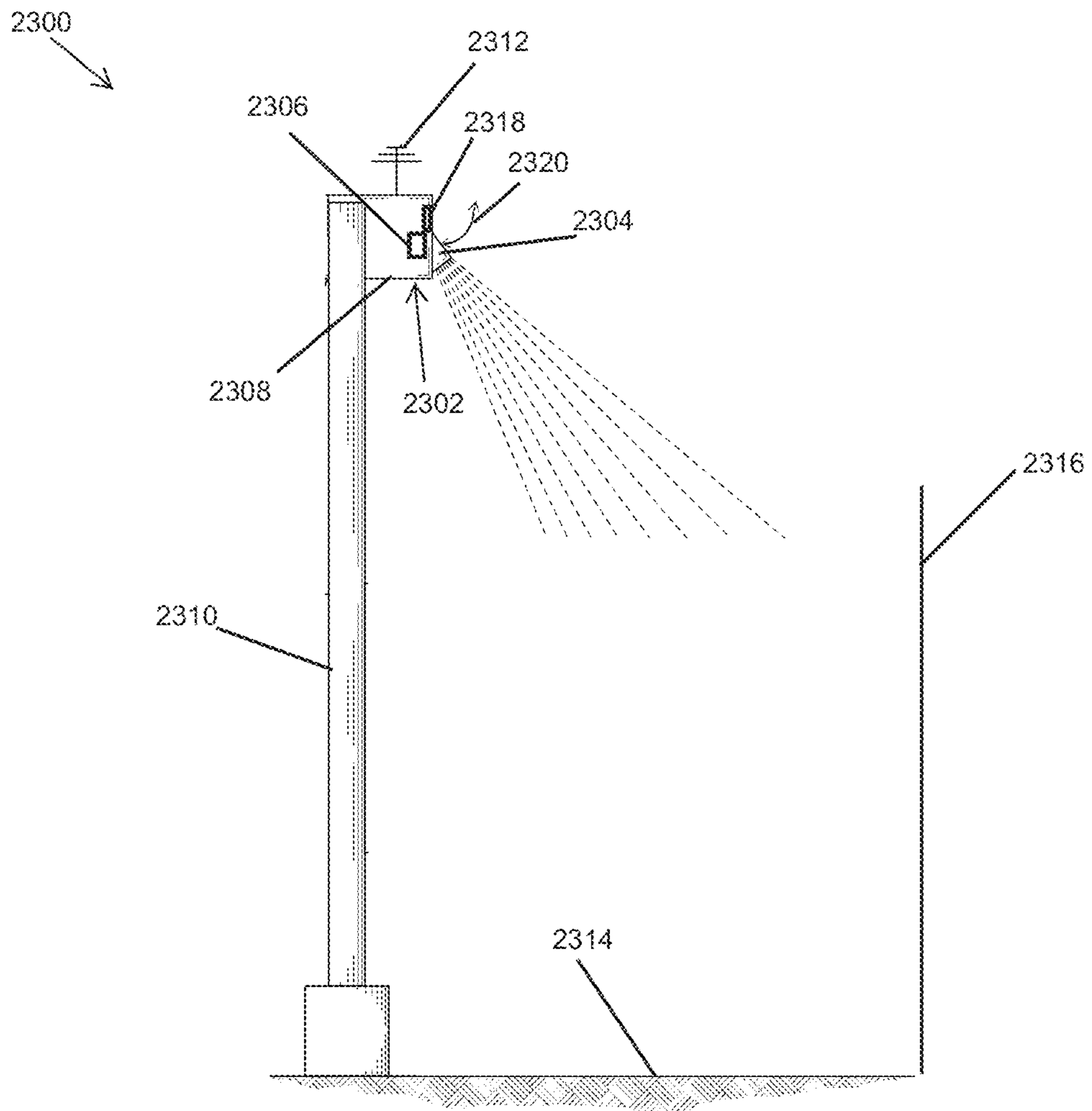


FIG. 23

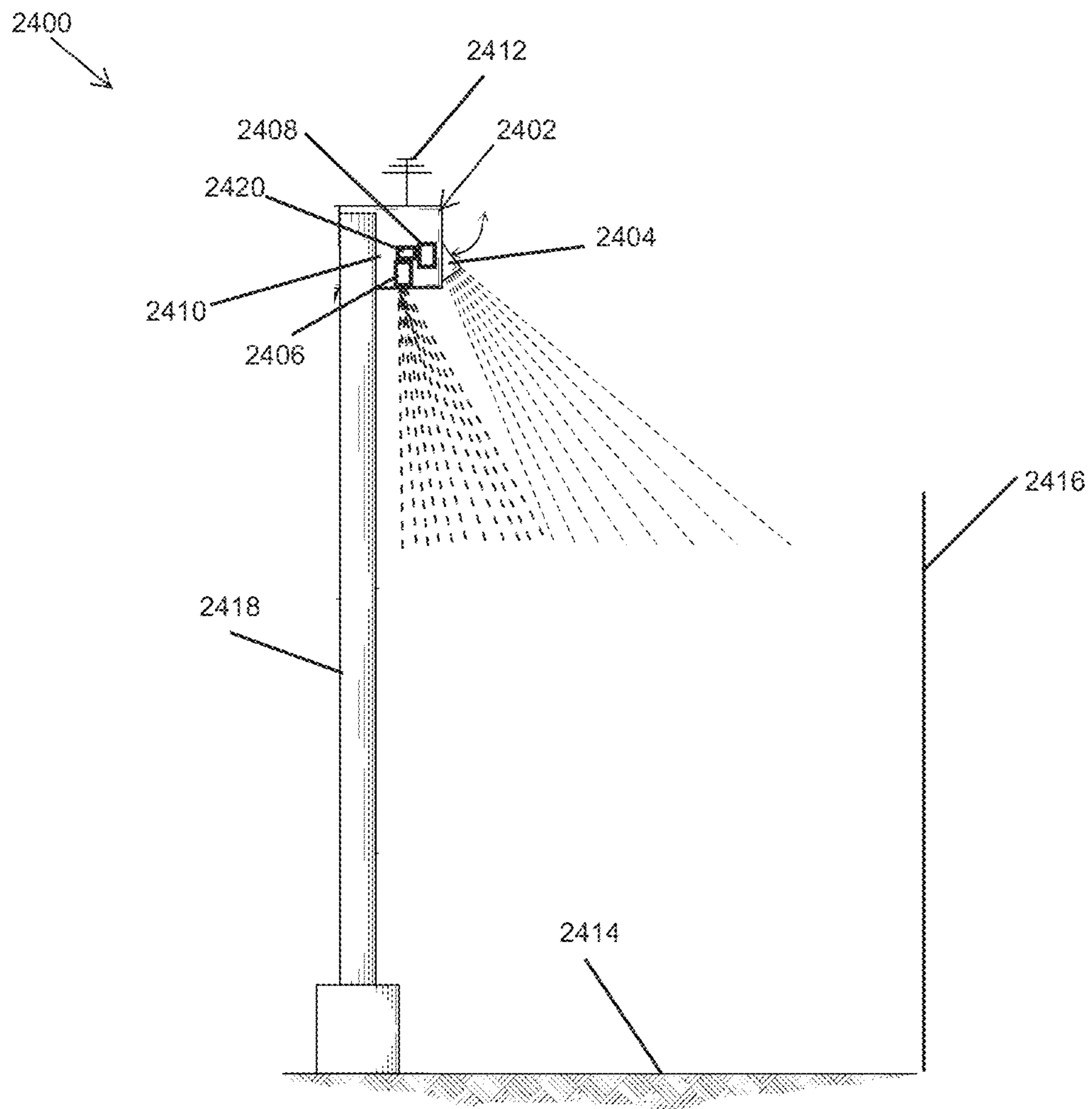


FIG. 24

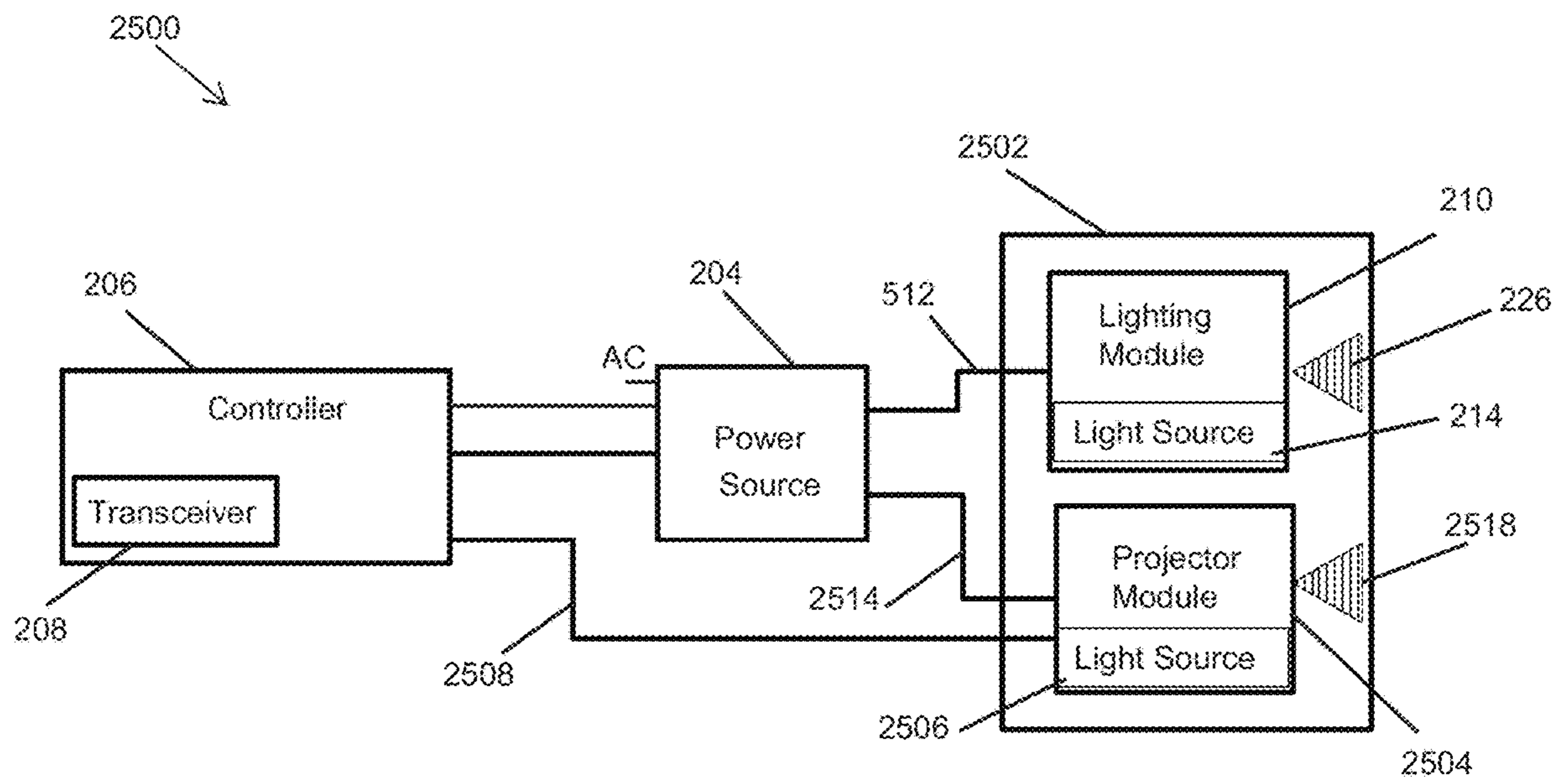


FIG. 25

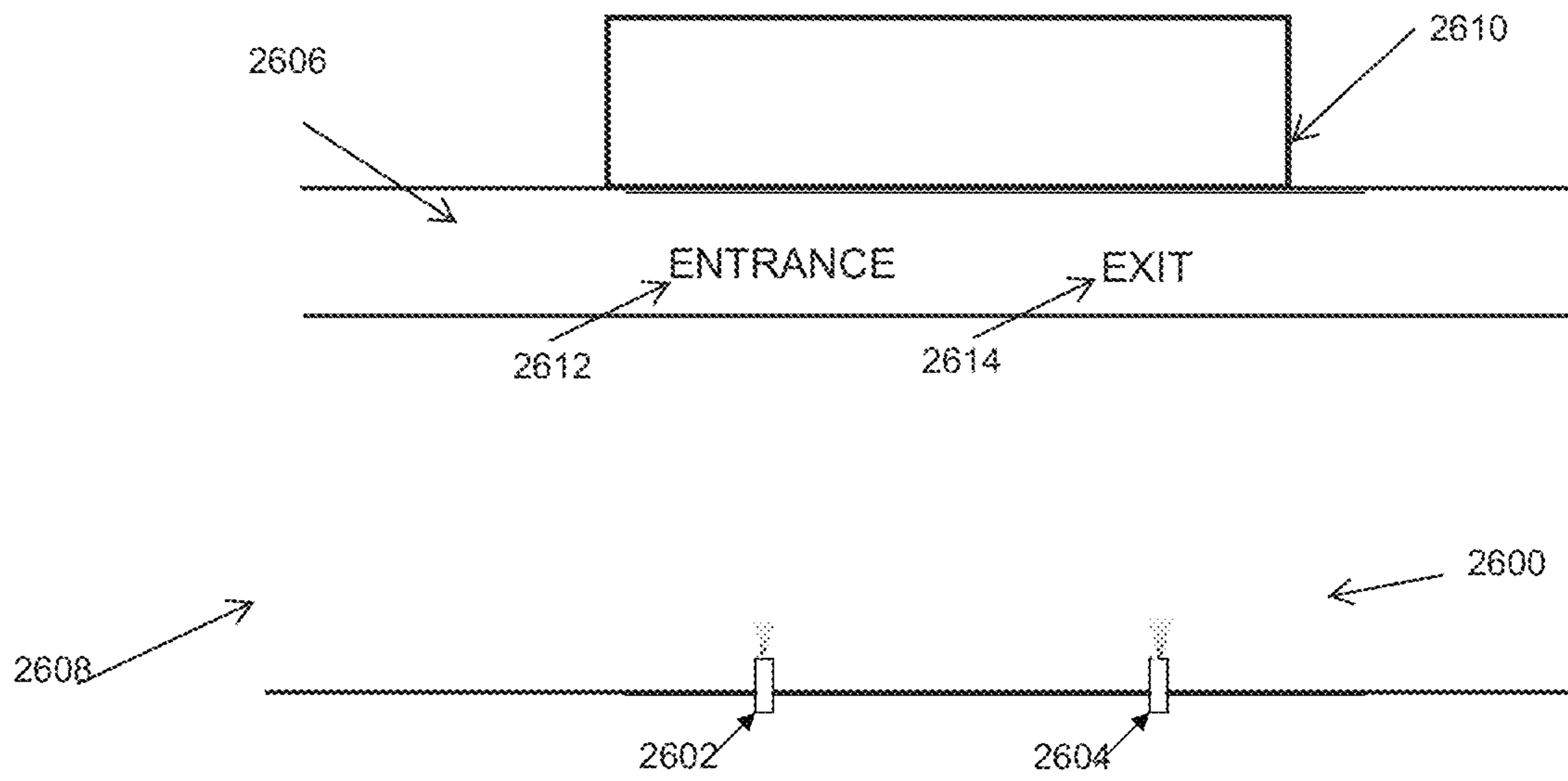


FIG. 26

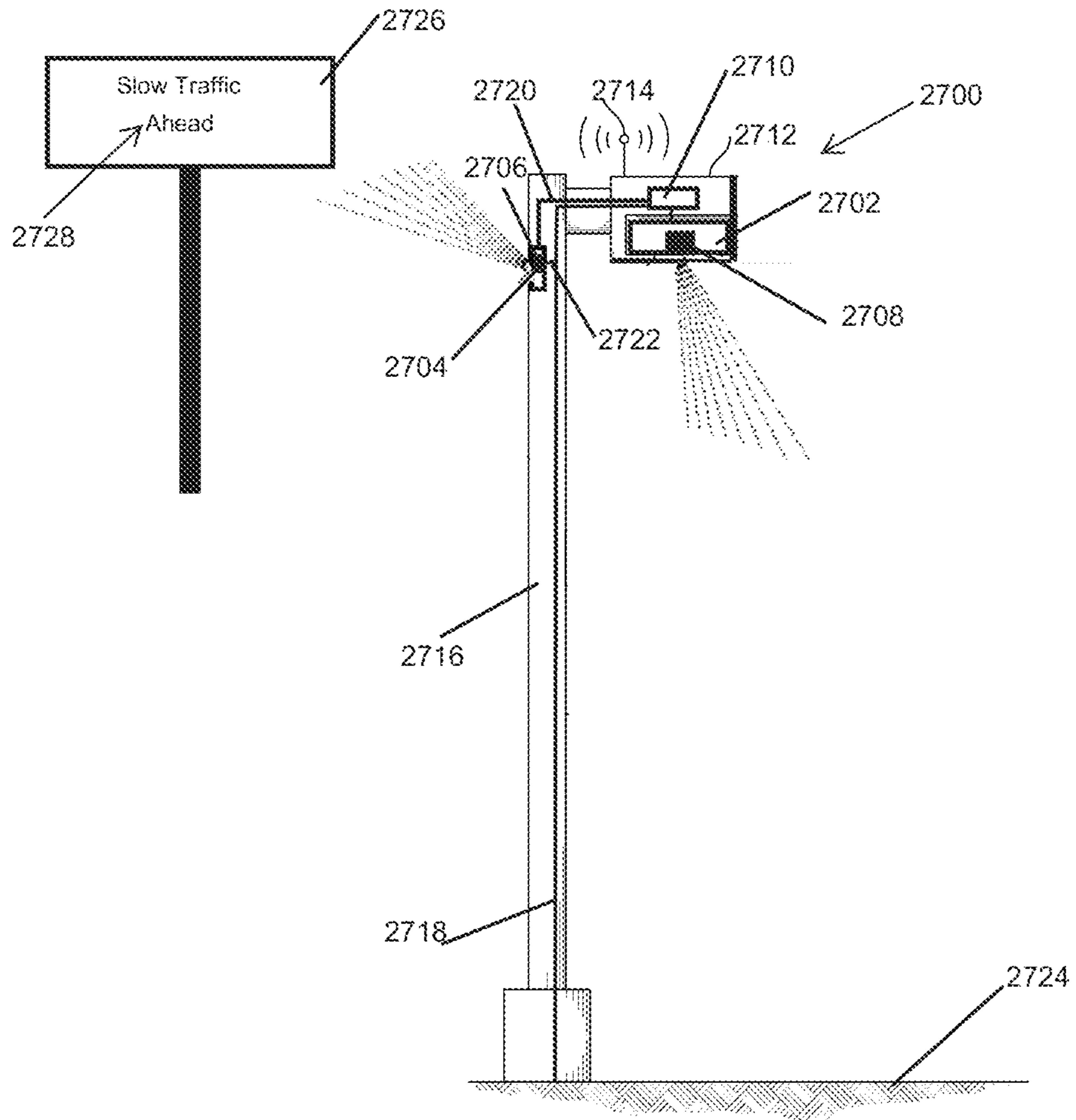


FIG. 27

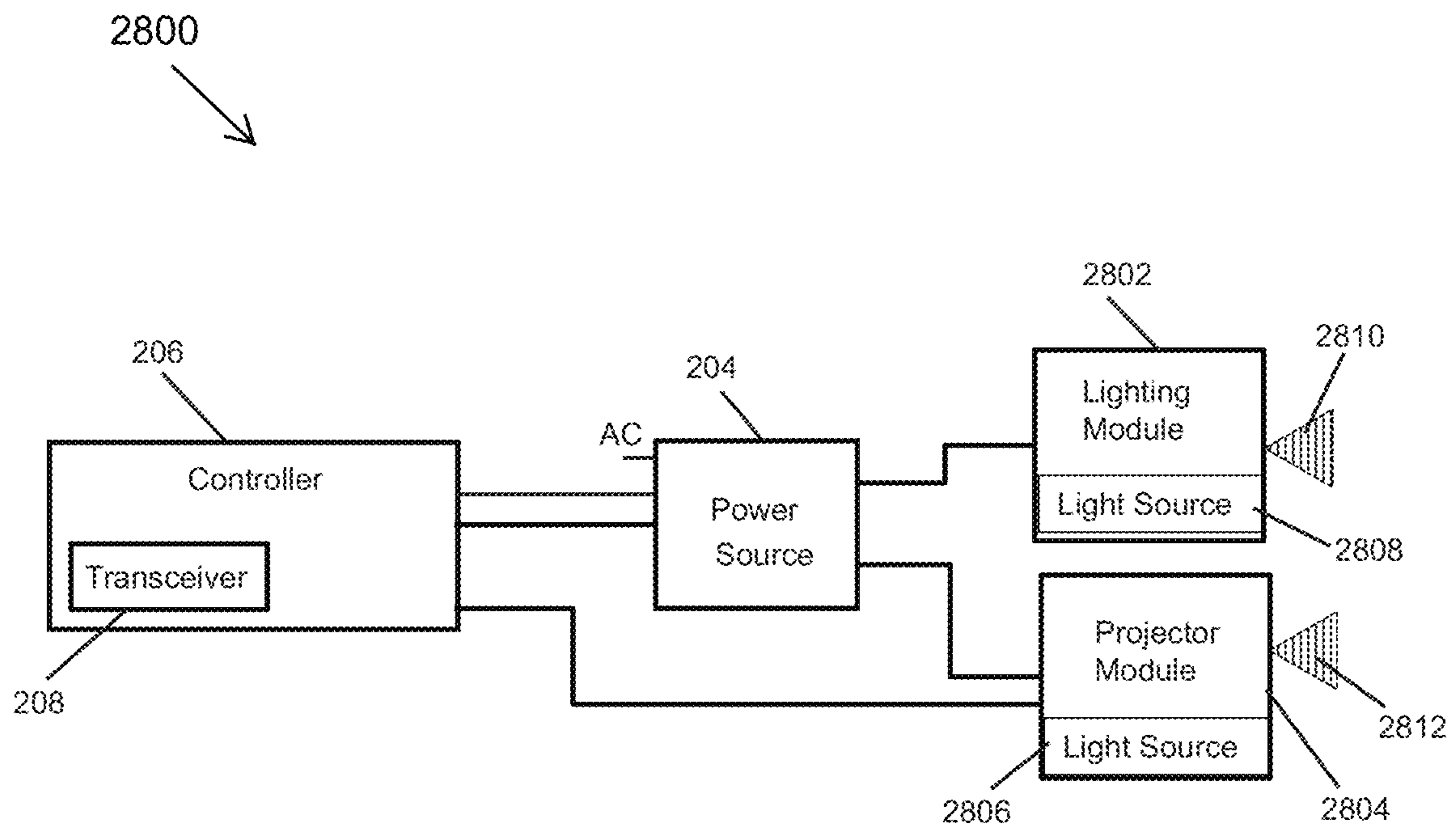


FIG. 28

**IMAGE AND LIGHT PROJECTION****CROSS REFERENCE TO RELATED APPLICATIONS**

The present application claims priority under 35 U.S.C. Section 119(e) to U.S. Provisional Patent Application No. 62/516,880, filed Jun. 8, 2017 and titled "Integrated Lighting and Projection," the entire content of which is incorporated herein by reference. The present application is related to U.S. patent application Ser. No. 16/000,665, filed Jun. 5, 2018 and titled "Image And Light Projection," and to U.S. patent application Ser. No. 16/000,648, filed Jun. 5, 2018 and titled "Image And Light Projection," the entire contents of which are incorporated herein by reference.

**TECHNICAL FIELD**

The present disclosure relates generally to lighting and image projection solutions, and more particularly to methods, systems, and devices of light and image projection.

**BACKGROUND**

Some standalone projectors are suspended from a ceiling and often require a wiring that is visible below the ceiling. Suspended projectors often interfere with the appearance of a room and may also be distracting to occupants. Some suspended projectors may also interfere with unobstructed views of occupants. Table top and other types of projectors may also take up space that can be used for other purposes and may also interfere with the appearance of the view.

Many light fixtures include a light source and may include other components such as a power source, a controller, wireless or wired communication capability, a heat sink, etc. Some of these lighting fixtures may be indoor lighting fixtures and others may be outdoor lighting fixtures. In some cases, the lighting fixtures may be ideally located or may have locations that support information projection. Thus, a solution that provides projection of light and images with no or minimal interference of a space may be desirable.

**SUMMARY**

The present disclosure relates generally to lighting and projection solutions, and more particularly to methods, systems, and devices of light and image projection. The projection fixtures described herein may be referred to as lighting and projector fixtures, and the projection systems described herein may be referred to as lighting and projector systems. In an example embodiment, a projection system includes a recessed projection fixture that includes a lighting module configured to emit a light and a projection module configured to project an image. The light emitted by the lighting module is used for projecting the image and for illumination. The projection system further includes a sensor, where the projection module projects the image in response to an occupancy detection by the sensor. The recessed projection fixture is oriented to direct the image toward a surface below the recessed projection fixture.

In another example embodiment, a projection system includes a projector device for recessed installation behind a ceiling, and an occupancy sensor communicably coupled to the projector device. The projector device is configured to project an image in response to an occupancy detection by the occupancy sensor, where the projector device is designed to project the image toward a surface below the ceiling.

In another example embodiment, a method of operation of a projection system includes receiving, by a projection fixture, a command to project an image, where the projection fixture includes a recessed projector device. The method further includes receiving, by the projection fixture, an image from an image source, and projecting, by the projection fixture, the image on a surface below the recessed projector device.

These and other aspects, objects, features, and embodiments will be apparent from the following description and the appended claims.

**BRIEF DESCRIPTION OF THE FIGURES**

Reference will now be made to the accompanying drawings, which are not necessarily drawn to scale, and wherein:

FIG. 1 illustrates a system of lighting and projector fixtures according to an example embodiment;

FIG. 2 illustrates a block diagram of a lighting and projector device according to an example embodiment;

FIG. 3 illustrates a lighting and projector fixture including a recessed projector device according to another example embodiment;

FIG. 4 illustrates a lighting and projector fixture including a recessed projector device according to another example embodiment;

FIG. 5 illustrates a lighting and projector fixture including a recessed projector device according to another example embodiment;

FIG. 6 illustrates a lighting and projector fixture including a recessed projector device inside a housing can according to an example embodiment;

FIG. 7 illustrates a housing can for a recessed projector device according to an example embodiment

FIG. 8 illustrates a housing can for a recessed projector device according to another example embodiment

FIG. 9 illustrates a lighting and projector fixture including a recessed projector device inside a housing can according to another example embodiment;

FIG. 10 illustrates a lighting and projector fixture including a recessed projector device inside a housing can according to another example embodiment;

FIGS. 11A-11D illustrate trims of lighting and projector fixtures according to example embodiments;

FIG. 12 illustrates a lighting and projector fixture including a recessed projector device inside a housing can according to another example embodiment;

FIG. 13 illustrates a lighting and projector fixture including a recessed projector device inside a housing can according to another example embodiment;

FIG. 14 illustrates a lighting and projector fixture including a recessed projector device inside a housing can according to another example embodiment;

FIGS. 15A and 15B illustrate a lighting and projector fixture recessed behind a ceiling according to another example embodiment;

FIG. 16 illustrates the lighting and projector fixture of FIGS. 15A and 15B from below a ceiling according to another example embodiment;

FIG. 17 illustrates a lighting and projector system including recessed projector devices according to another example embodiment;

FIG. 18 illustrates a lighting and projector system including recessed projector devices according to another example embodiment;



FIG. 19 illustrates a lighting and projector system including recessed projector devices according to another example embodiment;

FIG. 20 illustrates a lighting and projector system including recessed projector devices according to another example embodiment;

FIG. 21 illustrates a lighting and projector system projecting a shaped light according to an example embodiment;

FIGS. 22A-22F illustrate examples of shaped lights according to an example embodiment;

FIG. 23 illustrates a lighting and projector fixture including a lighting and projector fixture according to another example embodiment;

FIG. 24 illustrates a lighting and projector fixture including a lighting and projector fixture according to another example embodiment;

FIG. 25 illustrates a block diagram of a lighting and projector fixture according to an example embodiment;

FIG. 26 illustrates a system of lighting and projector fixtures according to another example embodiment;

FIG. 27 illustrates a lighting and projector system including a lighting and projector fixture according to another example embodiment; and

FIG. 28 illustrates a block diagram of a lighting and projector system according to an example embodiment.

The drawings illustrate only example embodiments and are therefore not to be considered limiting in scope. The elements and features shown in the drawings are not necessarily to scale, emphasis instead being placed upon clearly illustrating the principles of the example embodiments. Additionally, certain dimensions or placements may be exaggerated to help visually convey such principles. In the drawings, the same reference numerals appearing in different figures designate like or corresponding, but not necessarily identical, elements.

#### DETAILED DESCRIPTION OF THE EXAMPLE EMBODIMENTS

In the following paragraphs, example embodiments will be described in further detail with reference to the figures. In the description, well known components, methods, and/or processing techniques are omitted or briefly described. Furthermore, reference to various feature(s) of the embodiments is not to suggest that all embodiments must include the referenced feature(s).

Turning now to the figures, example embodiments are described. FIG. 1 illustrates a system 100 of lighting and projector fixtures according to an example embodiment. In some example embodiments, the system 100 includes lighting and projector fixtures 102, 104, 106 that may be installed in a ceiling 110. One or more of the lighting and projector fixtures 102, 104, 106 may operate to provide light for illumination and to project information. For example, one or more of the lighting and projector fixtures 102, 104, 106 may provide light for illumination in one mode and may operate to project information in another mode. Alternatively, one or more of the lighting and projector fixtures 102, 104, 106 may be recessed lighting fixtures only or recessed projector fixtures only.

In some example embodiments, each lighting and projector fixture 102, 104, 106 may include lighting components and projector components as shown in FIG. 2. When operating as a lighting fixture, each lighting and projector fixture 102, 104, 106 may provide an illumination light. When operating as a projector fixture, each lighting and projector fixture 102, 104, 106 may project an image on a surface such

as a wall 112 or a wall 118. Each lighting and projector fixture 102, 104, 106 may be capable of projecting images that are typically provided by standalone projectors. For example, each lighting and projector fixture 102, 104, 106 may project still images and moving images such as video. The images may also include 3-D image(s), such as a 3-D image of a person standing or sitting on a chair, etc. The terms image and images as used throughout this description include text, pictures, video, and other forms of visual information as may be contemplated by those of ordinary skill in the art with the benefit of this disclosure.

In some example embodiments, the images projected by the lighting and projector fixtures 102, 104, 106 may include information such as weather information, traffic information, safety information, instructions, directions, commercial information (e.g., advertisements, sales, etc.), still pictures, motion pictures, etc. To illustrate, the lighting and projector fixture 102 may project weather information 114 on the wall 112, and the lighting and projector fixture 106 may project a picture 116 on the wall 118.

In some example embodiments, each lighting and projector fixture 102, 104, 106 may include a light source that emits a light. For example, the light source may provide an illumination light when the respective lighting and projector fixture 102, 104, 106 operates as a lighting device and may provide a projection light when the respective lighting and projector fixture 102, 104, 106 operates as a projector device. The light source of each lighting and projector fixture 102, 104, 106 may include one or more light emitting diodes (LEDs). Each lighting and projector fixture 102, 104, 106 may also include a power source, such as an LED driver, that provides power to the light source that emits the light for illumination as well as for projection based on the power provided by the power source.

In some example embodiments, each lighting and projector fixture 102, 104, 106 may include a controller that controls the operation of the respective lighting and projector fixture 102, 104, 106. Each lighting and projector fixture 102, 104, 106 may also include a transceiver or another communication component that is used for wireless and/or wired communication between the lighting and projector fixture 102, 104, 106 and control devices, such as a processor 120 (e.g., a local server or a remote cloud server), a mobile device 124, a smart speaker 126, etc. For example, the transceiver of each lighting and projector fixture 102, 104, 106 may receive lighting related instructions and information as well as projection related instructions and information (e.g., an image to be projected on a wall, a screen, or another surface such as a floor or a table) from the processor 120, the mobile device 124, or a smart speaker 126. In some example embodiments, the lighting and projector fixture 102, 104, 106 may receive lighting related instructions and information from a control device directly (e.g., via Bluetooth Low Energy connection) or via a network device 122 (e.g., a wired and/or wireless router and/or gateway device).

To illustrate, instructions to turn on and off the lighting and projector fixtures 102, 104, 106 may be received by the respective transceiver and processed by the respective controller of the fixtures 102, 104, 106. As another example, instructions to set and adjust lighting intensity level, color temperature, and other characteristics of the lights provided by the lighting and projector fixtures 102, 104, 106 may be received by the respective transceivers and processed by the respective controllers.

In some example embodiments, one of the lighting and projector fixtures 102, 104, 106 may operate as a primary lighting and projector device that receives instructions and

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information from a control device and that communicates with the other lighting and projector fixtures based on the received instructions and information. For example, the lighting and projector fixture **102, 104, 106** may use network (e.g., Wi-Fi) addresses to communicate with each other. A control device, such as the mobile device **124**, may also use the network addresses of the lighting and projector fixture **102, 104, 106** to communicate with the devices.

In some example embodiments, a wall switch or a similar device may be used to control the powering on and off the lighting and projector fixture **102, 104, 106**. For example, images may be provided to one or more of the lighting and projector fixture **102, 104, 106** regardless of whether the lighting and projector fixture **102, 104, 106** are powered on. When the lighting and projector fixture **102, 104, 106** become powered on, the lighting and projector fixture **102, 104, 106** may start projecting the received image or images.

In some example embodiments, one or more of the lighting and projector fixtures **102, 104, 106** may include an integrated occupancy sensor (e.g., one or more motion sensors) or may be communicably coupled to one or more external occupancy sensors. For example, one or more occupancy sensors may control some operations of the lighting and projector fixtures **102, 104, 106**, such as turning on and off and the projection of images at one or more of the lighting and projector fixtures **102, 104, 106** may depend on occupancy detection.

In some example embodiments, one or more of the lighting and projector fixtures **102, 104, 106** may include a diffuser. For example, the lighting and projector fixture **102** may include a diffuser **108**. To illustrate with respect to the lighting and projector fixture **102**, the diffuser **108** may be in the path of the light from the light source of the lighting and projector fixture **102** when the lighting and projector fixture **102** operates to provide the illumination light. The diffuser **108** may be moved out of the path of the light when the lighting and projector fixture **102** operates as a projector device. For example, the diffuser **108** may be mechanically or electromechanically moveable.

In some example embodiments, the position of the diffuser **108** may be remotely controllable. For example, the controller of the lighting and projector fixture **102** may control the position of the diffuser **108** in response to commands received by the transceiver of the lighting and projector fixture **102**. In some example embodiments, the lighting and projector fixtures **104, 106** may each include a diffuser that can be used in a similar manner as described with respect to the diffuser **108**.

In some example embodiments, the lighting and projector fixtures **102, 104, 106** may each include a heat sink that is used to dissipate heat. For example, by using a heat sink, use of a fan may be omitted or a smaller fan may be included in the lighting and projector fixtures **102, 104, 106**.

By using the same light source to provide light for illumination as well as for projection of images, costs and challenges associated with installing a suspended projector may be reduced. In some example embodiments, the lighting and projector fixtures **102, 104, 106** may be recessed in the ceiling **100** as shown in FIG. 1 or may be recessed or otherwise installed behind another similar structure. By installing the lighting and projector fixtures **102, 104, 106** recessed in the ceiling **110**, the lighting and projector fixtures **102, 104, 106** blend in with a space compared to projectors that are suspended from a ceiling or placed on a table or a similar structure.

In some example embodiments, only some of the lighting and projector fixtures **102, 104, 106** may operate as a

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projector device. For example, the lighting and projector fixture **106** may be a projection only device and the lighting and projector fixtures **102, 104** may be lighting only devices. As another example, the lighting and projector fixtures **102, 104** may be projection only devices and the lighting and projector fixture **106** may be a lighting only device. In some example embodiments, the lighting and projector fixtures **102, 104, 106** may each include a standalone projector device without departing from the scope of this disclosure.

In some example embodiments, fewer or more lighting and projector fixtures than shown may be installed in the ceiling **110**. In some example embodiments, two or more lighting and projector fixtures may project information on an area, such as the wall **112**.

FIG. 2 illustrates a block diagram of a lighting and projector device **200** according to an example embodiment. In some example embodiments, the lighting and projector device **200** corresponds to or may be included in each of the lighting and projector fixtures **102, 104, 106** of FIG. 1. In some example embodiments, the lighting and projector device **200** may correspond to a projection only device, i.e., a projector device.

In some example embodiments, the lighting and projector device **200** may include a lighting and projector module **202**, a power source **204**, and a controller **206**. The controller **206** may control the operation of the lighting and projector module **202** and the power source **204**. For example, the controller **206** may include a microprocessor or a microcontroller that executes software code stored in a memory device of the lighting and projector device **200** to control the operations of the lighting and projector device **200**. The power source **204** may provide power to the lighting and projector module **202**. For example, the power source **204** may receive Alternating Current (AC) power and provide Direct Current (DC) power to the lighting and projector module **202** and to the controller **206**.

In some example embodiments, the lighting and projector module **202** may operate to provide light for illumination in one mode and may operate to project information (e.g., weather information, traffic information, safety related information), an image (e.g., a picture), etc. in another mode. To illustrate, the lighting and projector module **202** includes a lighting module **210** and a projector module **212**. The lighting module **210** may include a light source **214** that emits a light **226**. The light source **214** may include one or more discrete LEDs, one or more organic LEDs (OLEDs), an LED chip on board that includes one or more discrete LEDs, and/or an array of discrete LEDs. In some alternative embodiments, the lighting module **210** may include another type of light source without departing from the scope of this disclosure.

The projector module **212** may include components that support a projection technology that is based on one or more LCD, DLP, laser, etc. The projector module **212** may output a light **228** that projects an image, such as information, a photograph, etc. on a surface. For example, the light **226** from the lighting module **210** may serve as the light used by the projector module **212** to output the light **228**. That is, the projector module **212** may not include a separate light source that provides a light to project images. In some example embodiments, the projector module **212** may be oriented or adjustable to project the light **228** on a surface, such as a wall, a table, a floor, etc.

In some example embodiments, the entire or parts of the projector module **212** may be moved from the path of the light **226** such that the light **226** is used as an illumination light to illuminate an area such as a room. For example, the

entire or parts of the projector module **212** may be mechanically or electromechanically moved when the lighting and projector module **202** operates to provide illumination light instead of projection of an image. Alternatively, the projector module **212** may pass the light **226** through unmodified by information or image such that the light **228** is a continuation of the light **226**, where the light **228** serves as the illumination light. As another alternative, an image may be used to alter the light **226** to generate the light **228**, where the light **228** serves as an illumination light.

In some example embodiments, the controller **206** may control the power source **204** to adjust the light **226** provided by the lighting module. For example, the intensity level, the correlated color temperature (CCT), etc. of the light may be controlled by the controller **206** by controlling the power source **204** via an electrical connection **216** (e.g., one or more electrical wires). The controller **206** may also control the projector module **212** via an electrical connection **218**. For example, the controller **206** may provide to the projector module **212**, via the electrical connection **218**, the information, photograph, etc. to be projected by the lighting and projector module **202**.

In some example embodiments, the controller **206** may include a transceiver **208** that is used for communication between the lighting and projector module **202** and a remote control device, such as a mobile device. For example, controller **206** may receive via the transceiver **208** lighting control instructions as well as an image to be projected by the lighting and projector module **202**. The transceiver **208** may be a wired transceiver, a wireless transceiver, or a combination thereof. In some example embodiments, the transceiver **208** may be a receiver instead of a transceiver without departing from the scope of this disclosure.

In some example embodiments, the controller **206** may control whether the lighting and projector module **202** operates as a lighting fixture (i.e., to provide illumination light) or as a projector (i.e., to project an image). For example, the controller **206** may control the operation mode of the lighting and projector module **202** based on a user input received by the controller **206** via the transceiver **208**.

In some example embodiments, the controller **206** may control a diffuser, such as the diffuser **108** of FIG. 1, to move the diffuser out of the path of the light **228** when the light **228** is used to project an image. For example, the controller **206** may control a motor or another device to move the diffuser in or out of the path of the light **226** or the light **228** depending on whether the lighting and projector module **202** is used to provide illumination light or to project an image.

In some example embodiments, the power source **204** may provide power to the controller **206** via an electrical connection **220**. The power source **206** may also provide power to the lighting module **210** via an electrical connection **222** and to the projector module **212** via the electrical connection **224**. For example, the power source **206** may include one or more AC/DC converters. The power source **206** may also include DC/DC converters that may be used to generate power appropriate for the particular components that are powered by the power source **204**.

In some alternative embodiments, the components of the lighting and projector device **200** may be connected in a different configuration than shown without departing from the scope of this disclosure. In some alternative embodiments, the lighting and projector device **200** may include other components without departing from the scope of this disclosure. In some alternative embodiments, some of the components of the lighting and projector device **200** may be integrated into a single component without departing from

the scope of this disclosure. In some alternative embodiments, some of the components of the lighting and projector device **200** may be replaced by multiple components without departing from the scope of this disclosure. In some alternative embodiments, the lighting and projector device **200** may correspond to a standard projector without departing from the scope of this disclosure.

FIG. 3 illustrates a lighting and projector fixture **300** including a recessed projector device **302** according to another example embodiment. In some example embodiments, the lighting and projector fixture **300** may correspond to each of the lighting and projector fixtures **102**, **104**, **106**. In some example embodiments, the recessed projector device **302** may correspond to the lighting and projector device **200** shown in FIG. 2. In some example embodiments, the recessed projector device **302** may correspond to or may include a standard projector.

In some example embodiments, the lighting and projector fixture **300** includes a mounting frame **304**. For example, the recessed projector device **302** may be positioned on the mounting frame **304**. To illustrate, the recessed projector device **302** may be positioned on a surface **306** of the mounting frame **304**. The mounting frame **304** is designed to be positioned on a ceiling **310** or behind the ceiling **310**, wherein the recessed projector device **302** is positioned on the mounting frame **304** on an opposite side from the ceiling **310**.

In some example embodiments, the mounting frame **304** may have an opening **308**. For example, the opening **308** may be aligned with an opening **332** in the ceiling **310**. The recessed projector device **302** may be positioned on the mounting frame **304** to project a light or an image **328** through the opening **308** toward a surface **330** (e.g., a table, a floor, etc.) below the ceiling **310** and the recessed projector device **302**.

In some example embodiments, the recessed projector device **302** may include a protruding portion **312** that extends into the opening **308**. For example, images projected by the recessed projector device **302** may exit the recessed projector device **302** through the protruding portion **312**. To illustrate, a lens of the recessed projector device **302** may be positioned in the protruding portion **312**. Alternatively, the recessed projector device **302** may be omitted, and a portion of the recessed projector device **302** through which images exit the recessed projector device **302** may be lined up with and may be flush with the opening **308**.

In some example embodiments, the recessed projector device **302** may rest on the mounting frame **304** without being secured by a fastener or another device. For example, the recessed projector device **302** may be wide enough to rest on the surface **306** of the mounting frame **304** without tipping over or otherwise becoming misaligned with the opening **308**.

In some example embodiments, the lighting and projector fixture **300** may include a receptacle box **304**. For example, the receptacle box **314** may be attached to the mounting frame **304** by one or more fasteners or may be integrally formed with the mounting frame **304**. The receptacle box may include a power receptacle **316** that is connected to one or more electrical cables inside the receptacle box **314**. A plug **322** of a power cord **320** may be plugged into the receptacle **316** to provide power to the recessed projector device **302**.

In some example embodiments, the recessed projector device **302** may communicate with other devices and systems wirelessly. For example, the recessed projector device **302** may use a transceiver, such as the transceiver **208**, to

wireless communicate with other devices, such as control devices and image sources, using, for example, one or more wireless communication standards (e.g., Wi-Fi, Bluetooth, etc.). In some example embodiments, the recessed projector device **302** may communicate with other devices and systems using a wired connection. For example, a communication cable **324** including a connector **326** may be connected to the recessed projector device **302**, and the recessed projector device **302** may communicate with other devices and systems via the cable **324** using one or more communication standards (e.g., Ethernet). For example, the cable **324** may be a coax cable, a CAT-5e cable, etc.

In some example embodiments, the mounting frame **304** may be made from sheet metal or another suitable material as can be contemplated by those of ordinary skill in the art with the benefit of this disclosure. For example, the mounting frame **304** may be made by pressing, bending, cutting, etc. a sheet metal.

By placing the recessed projector device **302** behind the ceiling **310**, costs associated with suspending a standalone projector may be avoided. Because of the general availability of electrical wiring behind ceilings, the time and effort required to install the recessed projector device **302** can be lower compared to suspended projectors. Placing the recessed projector device **302** behind the ceiling **310** can also result in lower interference with a space and better use of a space compared to suspended and other types of projectors.

In some example embodiments, the lighting and projector fixture **300** may include other components than shown without departing from the scope of this disclosure. In some alternative embodiments, one or more components of the lighting and projector fixture **300** may be omitted or replaced with one or more other components without departing from the scope of this disclosure. For example, the receptacle box **314** may be omitted or replaced, for example, by a junction box. As another example, the plug **322** may be omitted. In some alternative embodiments, the recessed projector device **302** may have a different shape than shown without departing from the scope of this disclosure. In some alternative embodiments, the mounting frame **304** may have another shape than shown without departing from the scope of this disclosure. In some example embodiments, the recessed projector device **302** may be oriented to project the image **328** or a light in different directions than shown without departing from the scope of this disclosure.

FIG. **4** illustrates a lighting and projector fixture **400** including the recessed projector device **302** according to another example embodiment. In some example embodiments, the lighting and projector fixture **400** may correspond to each of the lighting and projector fixtures **102**, **104**, **106**. In some example embodiments, the lighting and projector fixture **400** includes a mounting frame **402** and a mirror holder **404**.

In some example embodiments, the recessed projector device **302** may be positioned on the mounting frame **402** in a similar manner as described with respect to FIG. **3**. To illustrate, the recessed projector device **302** may rest on the mounting frame **402** and may be oriented to project an image **412** or a light (e.g., an illumination or a shaped light) through an opening in a ceiling **410**. For example, an opening **408** in the mounting frame **402** may be at least partially aligned with the opening in the ceiling **410**. The recessed projector device **302** may also be powered and may communicate with other devices in a similar manner as described with respect to FIG. **3**.

In some example embodiments, a mirror **406** may be positioned in a cavity of the mirror holder **404**. For example, the mirror **406** may be attached to the mirror holder **404** by one or more fasteners such as a glue, a clip, or other means as can be contemplated by those of ordinary skill in the art with the benefit of this disclosure. The mirror **406** may be positioned to reflect the image **412** that is projected by the recessed projector device **302**. For example, the mirror **406** may reflect the image **412** to a different surface instead of, for example, the surface **330** that is directly below the recessed projector device **302**. In some example embodiments, the mirror **406** may be positioned in the mirror holder **404** to reflect the image **428** up toward a surface of the ceiling **410**. In some example embodiments, the mirror **406** may be a convex mirror.

In some example embodiments, the mirror holder **404** may be integrally formed in the mounting frame **402**. For example, the mirror holder **404** may extend down through the opening in the ceiling **410**. In some example embodiments, the mirror holder **404** may be attached to the mounting frame **402**, for example, by one or more fasteners, by soldering, etc. In some example embodiments, the mirror holder **404** may be part of a trim that is attached to the mounting frame **404** or the ceiling **410**.

In some example embodiments, the mirror holder **404** may have generally a shape of a half of a dome as illustrated in FIG. **4**. Alternatively, the mirror holder **404** may have other shapes without departing from the scope of this disclosure. In some alternative embodiments, the mirror holder **404** may be omitted and the mirror **406** may be attached to the mounting frame **402** by other means without departing from the scope of this disclosure. In some alternative embodiments, the protruding portion **312** may be omitted without departing from the scope of this disclosure. For example, no part of the recessed projector device **302** may extend into the opening **408** in the mounting frame **402**. In some example embodiments, the mounting frame **402** may be the mounting frame **304** shown in FIG. **3**.

FIG. **5** illustrates a lighting and projector fixture **500** including the recessed projector device **302** according to another example embodiment. Referring to FIGS. **3-5**, in some example embodiments, the recessed projector device **302** may be tilted as illustrated in FIG. **5**. For example, a support bracket **502** may be attached to the recessed projector device **302** and may hold the recessed projector device **302** lifted above a surface **504** of the mounting frame **402**. For example, the support bracket **502** may be secured to the mounting frame **402**. Alternatively or in addition, the support bracket **502** may be secured to the recessed projector device **302** by a fastener as can be readily understood by those of ordinary skill in the art with the benefit of this disclosure.

In some example embodiments, an edge **512** of the recessed projector device **302** may rest on the surface **504** of the mounting frame **402** when the recessed projector device **302** is tilted. For example, the support bracket **502** may be attached to the recessed projector device **302** an opposite side from the edge **512**.

In some example embodiments, tilting the recessed projector device **302** may enable projection of an image on a different surface or area than otherwise possible. In some example embodiments, tilting the recessed projector device **302** may provide additional flexibility in the positioning of the mirror **406** in the mirror holder **404**. In some example embodiments, tilting the recessed projector device **302** may allow use of a less expensive mirror.

In some example embodiments, mounting brackets **506**, **508** that are attached to the mounting frame **402** on opposite sides from each other may be used to attach the mounting frame **402** to ceiling structures such as joists. For example, the mounting brackets **506**, **508** may protrude up from the mounting frame **402** and may be fastened to parallel structures above the ceiling **410**. In some alternative embodiments, the mounting frame **402** may rest on the ceiling **410** or may be attached by other means.

In some example embodiments, a different support bracket than the support bracket **502** may be used to tilt or otherwise orient the recessed projector device **302** without departing from the scope of this disclosure. In some example embodiments, a second bracket may be used to provide a different tilting angle. In some alternative embodiments, a different type of structure than the support bracket **502** may be used without departing from the scope of this disclosure.

FIG. 6 illustrates a lighting and projector fixture **600** including a recessed projector device **602** inside a housing can **604** according to an example embodiment. In some example embodiments, the recessed projector device **602** may correspond to the lighting and projector device **200** shown in FIG. 2. In some example embodiments, the recessed projector device **602** may correspond to or may include a standard projector.

In some example embodiments, the recessed projector device **602** and the housing can **604** are positioned behind a ceiling **610**. The recessed projector device **602** may be positioned in the housing can **604** such that the recessed projector device **602** can project an image **608** or a light through an opening **614** in the ceiling **610**. For example, a protruding portion **612** of the recessed projector device **602** may be at least partially aligned with the opening **614** in the ceiling **610** such that the image **608** passing through the protruding portion **612** passes through the opening **614** toward a surface below the ceiling **610** and the recessed projector device **602**.

In some example embodiments, the recessed projector device **602** is attached to the housing can **604** at attachment point **624** of the recessed projector device **602**. For example, the recessed projector device **602** may be attached to the housing **102** by one or more fasteners, such as screws. In some example embodiments, the recessed projector device **602** may be rotatable about the attachment point **124** to orient the recessed projector device **602** after being securely attached to the housing can **604**. In some alternative embodiments, the recessed projector device **602** may be non-rotatably attached to the housing can **604**. In some example embodiments, the recessed projector device **602** may be attached to the housing can **604** using fasteners or torsion springs described below.

In some example embodiments, the housing can **604** is shown as having a cylindrical shape but may have another shape without departing from the scope of this disclosure. In some example embodiments, the housing can **604** may also have a top wall **606** having one or more openings **618**. For example, a power cord **620** attached to the recessed projector device **602** may pass through one of the openings **618**, and a communication cable **626** attached to the recessed projector device **602** may pass through the same or a different one of the openings **618**. In some example embodiments, the openings **618** and/or other openings in the cylindrical portion or the top wall **606** of the housing can **604** may allow for heat generated by the recessed projector device **602** to exit the housing can **604**.

In some example embodiments, the housing can **604** may be attached to a mounting structure **616**. For example, the

mounting structure **616** may be positioned on or above the ceiling **610** to ease installation of the lighting and projector fixture **600**. The mounting structure **616** may be positioned such the mounting structure **616** does not block the lower opening of the housing can **604**. The housing can **604** may be attached to a mounting structure **616** by one or more fasteners as may be contemplated by those of ordinary skill in the art with the benefit of this disclosure.

In some example embodiments, the housing can **604** and the mounting structure **616**, when present, may be formed from sheet metal using methods such as stamping, bending, etc. In some example embodiments, the recessed projector device **602** may be the same as the recessed projector device **302** and/or may operate in a similar manner as the recessed projector device **302**. In some example embodiments, the recessed projector device **602** may not include the protruding portion **612** or another protruding portion, and the image **608** may be projected by the recessed projector device **602** from a non-protruding portion that is aligned with the opening **614**. In some example embodiments, the mounting structure **616** may be omitted without departing from the scope of this disclosure.

FIG. 7 illustrates the housing can **702** for the recessed projector device **602** according to an example embodiment. In some example embodiments, the housing can **702** includes one or more attachment holes **704** that are across from one or more other attachment holes **714**. Fasteners **708**, **710** may be used to attach the recessed projector device **602** to the housing can **702**. For example, the fastener **708** may extend through one of the holes **704** and may be inserted into a threaded hole **706** of the recessed projector device **602**, and the fastener **710** may extend through one of the holes **714** and may be inserted into a threaded hole on the opposite side of the recessed projector device **602**. In some example embodiments, one of the holes **704**, **714** on each side of the housing can **702** may be used depending on the desired position of the recessed projector device **602** inside the housing can **702**.

In some example embodiments, the housing can **702** may be open both on the top and bottom sides of the housing can **702**. In some alternative embodiments, the housing can **702** may be open on the bottom side and may have a top wall such as the top wall **606** of the housing can **604** shown in FIG. 6. In some example embodiments, the housing can **702** may have just one attachment hole on each side. In some alternative embodiments, the housing can **702** may have another shape than shown without departing from the scope of this disclosure. In some example embodiments, the housing can **702** may be made from sheet metal using methods such as stamping, bending, etc.

FIG. 8 illustrates a housing can **802** for a recessed projector device according to another example embodiment. In some example embodiments, torsion springs **804**, **806** may be used to attach the recessed projector device **602** to the housing can **802**. For example, the torsion spring **804** may be attached to the recessed projector device **602** on a one side, and the torsion spring **806** may be attached to the recessed projector device **602** on an opposite side. To illustrate, the torsion springs **804**, **806** may be attached to fasteners (e.g., screws) that are attached to the recessed projector device **602**.

In some example embodiments, the housing can **802** may include one or more torsion spring receivers **808**, **810** on each side of the housing can **802**, and the torsion springs **804**, **806** may be attached to the torsions spring receivers **808**, **810**. Particular ones of the torsion spring receivers **808**, **810** on each side of the housing can **802** may be used

depending on the desired position of the recessed projector device **602** inside the housing can **802**.

In some example embodiments, the housing can **802** may be open both on the top and bottom sides of the housing can **802**. In some alternative embodiments, the housing can **802** may be open on the bottom side and may have a top wall such as the top wall **606** of the can **604** shown in FIG. 6. In some example embodiments, the housing can **802** may have just one torsion spring receiver. In some alternative embodiments, the housing can **802** may have another shape than shown without departing from the scope of this disclosure. In some example embodiments, the housing can **802** may be made from sheet metal using methods such as stamping, bending, etc.

FIG. 9 illustrates a lighting and projector fixture **900** including the recessed projector device **602** inside the housing can **604** according to another example embodiment. In some example embodiments, the recessed projector device **602** and the housing can **604** may be positioned behind a ceiling **910** to project an image **908** or a light (e.g., an illumination or a shaped light) to a surface below the ceiling **910**. The recessed projector device **602** may be attached to the housing can **604** in a manner described above with respect to FIGS. 6-8. The recessed projector device **602** may be powered and may communicate with other devices in a similar manner as described with respect to the recessed projector device **302** of FIG. 3 and with respect to FIG. 6.

In some example embodiments, the lighting and projector fixture **900** is substantially similar to the lighting and projector fixture **600** of FIG. 6. Focusing on the main differences, in some example embodiments, the lighting and projector fixture **900** includes a mirror holder **902** holding a mirror **904** that may be attached to the mirror holder **902** by an adhesive, one or more clips, or by other means as can be contemplated by those of ordinary skill in the art with the benefit of this disclosure. The mirror **904** may be positioned in a cavity of the mirror holder **902** to reflect the image **908** or a light that is projected by the recessed projector device **602** to a different surface. To illustrate, the mirror **904** may reflect the image **908** toward a surface of a wall **914** instead of a table or a floor directly below the recessed projector device **602**. In some example embodiments, the mirror **904** may be positioned in the mirror holder **902** to reflect the image **908** up toward a surface of the ceiling **910**. In some example embodiments, the mirror **904** may be a convex mirror.

In some example embodiments, the mirror holder **902** may be attached to the ceiling **910**. Alternatively or in addition, the mirror holder **902** may be attached to the housing can **604** and may extend through the opening **912** in the ceiling **910**. In some example embodiments, the mirror holder **902** may be part of a trim that is attached to the ceiling **910** and/or the housing can **604**.

In some example embodiments, the mirror holder **902** may have a shape of a half of a dome as illustrated in FIG. 9. Alternatively, the mirror holder **902** may have other shapes without departing from the scope of this disclosure. In some alternative embodiments, the mirror holder **902** may be omitted and the mirror **904** may be attached to the ceiling **910** or the housing can **604** by other means without departing from the scope of this disclosure. In some alternative embodiments, the protruding portion **612** may be omitted without departing from the scope of this disclosure. For example, no part of the recessed projector device **602** may extend into the opening **912** in the ceiling **910**. In some example embodiments, the mirror holder **902** may be attached to or may be integrally formed with the mounting

structure **906**, which generally corresponds to the mounting structure **616** shown in FIG. 6. In some alternative embodiments, the housing can **604** may have a fully or substantially open top end without departing from the scope of this disclosure.

FIG. 10 illustrates a lighting and projector fixture **1000** including a recessed projector device **602** inside a housing can **604** according to another example embodiment. In some example embodiments, the recessed projector device **602** and the housing can **604** may be positioned behind a ceiling **1010**, and the recessed projector device **602** may be oriented to project an image **1008** or a light (e.g., an illumination or a shaped light) to a surface below the ceiling **1010**. The recessed projector device **602** may be attached to the housing can **604** in a manner described above with respect to FIGS. 6-9. The recessed projector device **602** may be powered and may communicate with other devices in a similar manner as described with respect to the recessed projector device **302** of FIG. 3 and with respect to FIGS. 6 and 9.

In some example embodiments, the lighting and projector fixture **1000** is substantially similar to the lighting and projector fixture **600** of FIG. 6 and the lighting and projector fixture **900** of FIG. 9. Focusing on the main differences, in some example embodiments, the lighting and projector fixture **1000** includes a mirror holder **1002** holding a mirror **1004**, and a trim **1006** attached to the housing can **604**. In some example embodiments, the trim **1006** may include the mirror holder **1002**, or the trim **1006** may be a separate structure from the mirror holder **1002**. In some example embodiments, the mirror holder **1002** may be attached to the ceiling **1010**. The mirror **1004** may be attached to the mirror holder **1002** by one or more fasteners, such as a glue, a clip, or other means as can be contemplated by those of ordinary skill in the art with the benefit of this disclosure.

In some example embodiments, the trim **1006** may have an opening **1012** that is at least partially aligned with an opening in the ceiling **1010** such that the image **1008** projected by the recessed projector device **602** reaches the mirror **1004** positioned in the mirror holder **1002**. The mirror **1004** may be positioned in a cavity of the mirror holder **1002** to reflect the image **1008** or a light that is projected by the recessed projector device **602** toward a surface, such as a surface of a wall **1014**. In some example embodiments, the mirror **1004** may be positioned in the mirror holder **1002** to reflect the image **1008** up toward a surface of the ceiling **1010**. In some example embodiments, the mirror **1004** may be a convex mirror.

FIGS. 11A-11D illustrate trims of lighting and projector fixtures according to example embodiments. For example, a trim **1100** shown in FIG. 11A may be used in the lighting and projector fixtures of FIGS. 3 and 6. The trims **1102-1106** may be used in the fixtures of FIGS. 4, 5, 9, and 10. For example, a mirror holder **1110** of the trim **1102** may hold a mirror **1112** as shown in FIG. 11B. As another example, as shown in FIG. 11C, a mirror holder **1114** of the trim **1104** may hold a mirror in a cavity **1116** to reflect an image directed to the mirror from a projector device such as the projector devices **302**, **602** described above. In some example embodiments, a mirror holder **1118** of the trim **1106** shown in FIG. 11D may hold a mirror that is positioned to reflect an image or a light directed to the mirror from a projector device such as the projector devices **302**, **602** described above.

FIG. 12 illustrates a lighting and projector fixture **1200** including the recessed projector device **602** inside the housing can **1204** according to another example embodiment. In

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some example embodiments, the lighting and projector fixture **1200** is substantially similar to the lighting and projector fixture **1000** of FIG. **10**. Focusing on the main differences, in some example embodiments, the housing can **1204** is fully open at the top end in contrast to the housing can **604** of FIG. **10** that has a top wall having openings for routing wires and for dissipating heat. In some example embodiments, in FIG. **12**, the recessed projector device **602** may also be rotated in contrast to the position of the recessed projector device **602** in FIG. **10**.

In some example embodiments, positioning the recessed projector device **602** in the rotated position shown in FIG. **12** may enable the projection of an image or a light by the lighting and projector fixture **1200** on a particular surface or area. In some example embodiments, rotating the recessed projector device **602** as shown may provide additional flexibility in the positioning of a mirror positioned in a mirror holder below the recessed projector device **602**.

FIG. **13** illustrates a lighting and projector fixture **1300** including the recessed projector device **602** inside a housing can **1204** according to another example embodiment. In some example embodiments, the lighting and projector fixture **1300** is substantially similar to the lighting and projector fixture **1000** of FIG. **10**. Focusing on the main differences, in some example embodiments, the housing can **1204** is fully open at the top end in contrast to the housing can **604** of FIG. **10** that has a top wall having openings for routing wires and for dissipating heat. In some example embodiments, in FIG. **13**, a trim **1302** having a cylindrical portion **1306** may be attached to the housing can **1204**. For example, the protruding portion of the recessed projector device **602** may be aligned with the cylindrical portion **1306** or may be at least partially positioned in the cylindrical portion **1306**.

FIG. **14** illustrates a lighting and projector fixture **1400** including the recessed projector device **602** inside the housing can **1204** according to another example embodiment. In some example embodiments, the lighting and projector fixture **1400** is substantially similar to the lighting and projector fixture **1000** of FIG. **10**. Focusing on the main differences, in some example embodiments, the housing can **1204** is fully open at the top end in contrast to the housing can **604** of FIG. **10** that has a top wall having openings for routing wires and for dissipating heat. In some example embodiments, in FIG. **14**, a trim **1402** is positioned around the perimeter of the housing can **1204** in contrast to the trim **1006** shown in FIG. **10** that may be positioned inside or aligned with the perimeter of the housing can **604**.

FIGS. **15A** and **15B** illustrate a lighting and projector fixture **1500** including a projector device **1502** recessed behind a ceiling **1510** according to another example embodiment. In some example embodiments, the fixture **1500** includes the projector device **1502** positioned in a housing can **1504**. The housing can **1504** may be attached to a mounting structure **1512** by fasteners, such as a fastener **1516**. In some example embodiments, fasteners such as a fastener **1506** may be used to attach the projector device **1502** to the housing can **1504**.

In some example embodiments, the mounting structure **1512** may rest on the ceiling **1510**. Alternatively or in addition, the mounting structure **1512** may be attached to hanger bars, such as the hanger bar **1514**, that may be used to attach the mounting structure **1512** to structures such as joists behind the ceiling **1510**.

In some example embodiments, the projector device **1502** may communicate with other devices, such as control devices (e.g., a mobile device, a controller, etc.) and image

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sources (e.g., a video camera, a cloud server, etc.), using a cable **1508**. For example, the cable **1508** may be coupled to a network device or another device such as a laptop, etc. One or more wires may be used to provide power to the projector device **1502** without the need for the wires to extend below the ceiling **1510**.

FIG. **16** illustrates the lighting and projector fixture **1500** of FIGS. **15A** and **15B** from below a ceiling according to another example embodiment. Referring to FIGS. **15A**, **15B**, and **16**, the lighting and projector fixture **1500** may include a mirror holder **1602** that holds a mirror similar to the mirrors described above. For example, the mirror may be positioned in the mirror holder **1602** to reflect an image or a light from the projector device **1502** toward the screen **1604** that is below the ceiling **1510**. The mirror holder **1602** may be a standalone structure or may be part of another structure, such as a trim, as described above.

As can be seen in FIG. **16**, the lighting and projector fixture **1500** requires a relatively small space in the side of the ceiling **1510** facing occupants, and thus, eliminates or reduces the interference that traditionally results from suspended or desktop projectors.

FIG. **17** illustrates a lighting and projector system **1700** including recessed projector devices according to another example embodiment. For example, the lighting and projector system **1700** may be similar to the system **100** of FIG. **1** and may operate in a substantially similar manner.

In some example embodiments, the system **1700** includes recessed projector devices **1702**, **1704**, **1706**. For example, the recessed projector devices **1702**, **1704**, **1706** may each be one of the recessed lighting and projector fixtures (e.g., the fixture **400**, the fixture **500**, the fixture **900**, etc.) described above and may be installed in a ceiling **1710** in a similar manner as described above. In some example embodiments, the recessed projector devices **1702**, **1704**, **1706** may be recessed in the ceiling **1710** and may be controllable by one or more control devices, such as a handheld device **1708**, a smart speaker **1718**, external or integrated occupancy sensors, etc.

In some example embodiments, lighting fixtures **1712**, **1714**, **1716** may be installed in the ceiling **1710**. The lighting fixtures **1712**, **1714**, **1716** may each be wired and/or wireless communication capability. For example, the lighting fixtures **1712**, **1714**, **1716** may be controllable by a control device, such as the handheld device **1708**, the smart speaker **1718**, external or integrated occupancy sensors, etc.

In some example embodiments, the handheld device **1708** may wirelessly communicate with the recessed projector devices **1702**, **1704**, **1706** and the lighting fixtures **1712**, **1714**, **1716** using one or more communication standards such as Wi-Fi, BLE, ZigBee, etc. For example, the handheld device **1708** may communicate with the recessed projector devices **1702**, **1704**, **1706** through a network device **1720** that may include a wired and/or wireless router, a gateway device for communication with the internet including cloud servers, etc.

In some example embodiments, a processor device **1722** may control operations of the projector devices **1702**, **1704**, **1706**, for example, based on communications with the handheld device **1708**, the smart speaker **1718**, external or integrated occupancy sensors as well as the projector devices **1702**, **1704**, **1706**. For example, the processor device **1722** may be a local server that serves as a central controller that communicates with the handheld device **1708**, the smart speaker **1718**, external or integrated occupancy sensors, and the projector devices **1702**, **1704**, **1706** via the network device **1720**. Alternatively, the processor

device 1722 may be a remote cloud server that communicates with the handheld device 1708, the smart speaker 1718, external or integrated occupancy sensors, and the projector devices 1702, 1704, 1706 through the network device 1720 and that operates in a similar manner as a local server. The processor device 1722 may communicate with and control operations of the lighting fixtures 1712, 1714, 1716 in a similar manner.

In some example embodiments, the recessed projector device 1702 is positioned to project an image or a light (e.g., a shaped light) on a surface 1724. The recessed projector device 1704 may be positioned to project an image or a light (e.g., a shaped light) on a surface 1726, and the recessed projector device 1706 is positioned to project an image or a light (e.g., a shaped light) on a surface 1728. In some example embodiments, the projector devices 1702, 1704, 1706 may each have a network address or identifier that can be used by other devices to communicate with the projector devices 1702, 1704, 1706. In some example embodiments, the lighting fixtures 1712, 1714, 1716 may also have network addresses or identifiers.

In some example embodiments, the handheld device 1708 (e.g., a mobile phone or a tablet) may include a control application 1730 that is executed by the handheld device 1708 to control operations of the projector devices 1702, 1704, 1706. For example, the control application 1730 may be configured, automatically or through a manual process, with the network addresses of the projector devices 1702, 1704, 1706 as can be readily understood by those of ordinary skill in the art with the benefit of this disclosure.

In some example embodiments, a user may select a particular one of the projector devices 1702, 1704, 1706 using the control application 1730. For example, the control application 1730 may provide a drop-down menu or otherwise provide a list of the projector devices 1702, 1704, 1706 on the display screen of the handheld device 1708. The control application 1730 may provide input interfaces for use by a user to power on or off one or more of the projector devices 1702, 1704, 1706. The control application 1730 may also provide an input interface on the display screen of the handheld device 1708 to select casting of images from the handheld device 1708 to one or more of the projector devices 1702, 1704, 1706.

In some example embodiments, the handheld device 1708 may associate one or more network addresses of the projector devices 1702, 1704, 1706 with particular user inputs. For example, a user may configure the control application 1730 to make such associations. Alternatively or in addition, a user may update a default association of particular user inputs with network addresses of the projector devices 1702, 1704, 1706. For example, the control application 1730 may associate a swipe (e.g., using a finger or a stylus) of the touch-sensitive display screen toward a particular side (e.g., right side) of the display screen with a command for a particular one or more of the projector devices 1702, 1704, 1706 to project one or more images. In response to such a swipe of the display screen, the handheld device 1708 may transmit the command to the particular one or more of the projector devices 1702, 1704, 1706.

To illustrate, the projector device 1702 may be associated with a swipe to the top side of the handheld device 1708 (and, thus the top side of the display screen), and the handheld device 1708 may transmit a command to the projector device 1702 to project an image or a light. The projector device 1704 may be associated with a swipe to the left side of the handheld device 1708 in a similar manner, and the projector device 1706 may be associated with a

swipe to the right side of the handheld device 1708 in a similar manner. Additional projector devices may be associated with swipes to particular corners of the handheld device 1708. In some alternative embodiments, more directionally specific swipes of the display screen of the handheld device 1708 may be associated with commands to the projector devices 1702, 1704, 1706. In some example embodiments, two same-direction swipes may result in one or more of the projector devices 1702, 1704, 1706 starting to project an image or a light in response to the first swipe and stopping the projection of the image in response to the second swipe. Two same-direction swipes may also result in one or more of the projector devices 1702, 1704, 1706 stopping the projection of an image or a light in response to the first swipe and starting to project an image or a light in response to the second swipe.

In some example embodiments, a particular swipe or user input may be associated with multiple or all projector devices of the lighting and projector system 1700 and may result in multiple or all of the projector devices 1702, 1704, 1706 projecting one or more images or stopping the projection of one or more images. In some example embodiments, the handheld device 1708 may send a command to a different one of the projector devices 1702, 1704, 1706 to project an image in response to a particular user input (e.g., a down swipe), where the handheld device 1708 sequences through the projector devices 1702, 1704, 1706.

In some example embodiments, a user input (e.g., a swipe) to select one or more of the projector devices 1702, 1704, 1706 to project one or more images may result in the handheld device 1708 sending one or more commands to the unselected ones of the projector devices 1702, 1704, 1706 to stop the projection of one or more images. For example, a user may change the projection of an image or images by the projector device 1702 to the projection of an image or images by the projector device 1704 by selecting the projector device 1704 (e.g., swiping left) on the handheld device 1708. Alternatively, the handheld device 1708 may send a command to particular ones of the projector devices 1702, 1704, 1706 to stop projections of images if a user provides an input to the handheld device 1708 indicating such an action.

In some example embodiments, the images projected by the projector devices 1702, 1704, 1706 may be provided to the projector devices 1702, 1704, 1706 regardless of whether the projector devices 1702, 1704, 1706 are powered on or instructed to project the images. For example, the video source (e.g., a video camera) may continuously provide a video feed to the projector devices 1702, 1704, 1706, and the particular one or more of the projector devices 1702, 1704, 1706 that are powered on or instructed to project images may project the image (e.g., the video).

In some alternative embodiments, the projector devices 1702, 1704, 1706 may each retrieve information (e.g., weather information, traffic information, etc.) from a source, such as a cloud server (e.g., the processor device 1722), in response to a respective command from the handheld device 1708. The projector devices 1702, 1704, 1706 project an image that includes the retrieved information. A command from the handheld device 1708 to project images may be a power on command or another command that results in the projector devices 1702, 1704, 1706 projecting images.

In some example embodiments, the projector devices 1702, 1704, 1706 may retrieve information (e.g., weather information, etc.) based on a timer included in or coupled to the projector devices 1702, 1704, 1706. The projector devices 1702, 1704, 1706 may project an image including



the retrieved information when the projector devices **1702**, **1704**, **1706** receive a respective command from the handheld device **1708** to project images. In some example embodiments, a command to project an image may not include information about the type of image or the source of the image, and the image (e.g., weather information, traffic information, a video, etc.) may be provided to or retrieved by the projector devices **1702**, **1704**, **1706** independent of commands to project images.

In some example embodiments, the handheld device **1708** may wirelessly send a dim command to one or more of the lighting fixtures **1712**, **1714**, **1718** in response to receiving one or more user inputs selecting one or more of the projector devices **1702**, **1704**, **1706** to project one or more images or one or more lights. For example, the handheld device **1708** may send the dim command to one or more of the lighting fixtures **1712**, **1714**, **1718** before or after sending one or more commands to the projector devices **1702**, **1704**, **1706** to project one or more images in response to a user input. In some example embodiments, one or more of the projector devices **1702**, **1704**, **1706** may send a dim command to one or more of the lighting fixtures **1712**, **1714**, **1718** in response to receiving a command to project one or more images.

For example, the projector devices **1702**, **1704**, **1706** may be configured with the network address of the lighting fixtures **1712**, **1714**, **1716**, and may send a targeted or a broadcast dim command. The lighting fixtures **1712**, **1714**, **1716** may dim their emitted lights to a particular intensity level in response to receiving the dim command. The lighting fixtures **1712**, **1714**, **1716** may undim their lights in response to receiving an undim command from the handheld device **1708** or from one or more of the projector devices **1702**, **1704**, **1706** that may send an undim command in response to receiving a command to stop projecting a light. In some example embodiments, dim and undim commands from the handheld device **1708** may have a higher priority than such commands from the projector devices **1702**, **1704**, **1706**. In some example embodiments, dimming and undimming of lights from the lighting fixtures may be controlled by the processor device **1722**, which may serve as a local control.

In some example embodiments, the smart speaker **1718** may control the projector devices **1702**, **1704**, **1706** in a similar manner as described with the handheld device **1708** where user inputs to the handheld device **1708** are replaced by vocal commands provided to the smart speaker **1718**. In some example embodiments, the smart speaker **1718** may be configured, automatically or through a manual process by a user, with the network addresses of the projector devices **1702**, **1704**, **1706** and the lighting fixtures **1712**, **1714**, **1716** as can be readily understood by those of ordinary skill in the art with the benefit of this disclosure. Additional configuration of the smart speaker **1718**, for example, to associate labels with one or more of the projector devices **1702**, **1704**, **1706** and the lighting fixtures **1712**, **1714**, **1716** may be performed by a user in a standard manner of configuring smart speakers.

In some example embodiments, the smart speaker **1718** (e.g., AMAZON ECHO, GOOGLE HOME, etc.) may transmit commands to the one or more projector devices **1702**, **1704**, **1706** in response to vocal commands. For example, the vocal commands may be instructions to power on, off, etc. the one or more projector devices **1702**, **1704**, **1706**. The vocal commands may also be instructions to have one or more of the projector devices **1702**, **1704**, **1706** project one or more images. To illustrate, a vocal command may be to

have the projector device **1702** project particular information, such as weather information, where the projector device **1702** is identified by label, network address, etc. In response the smart speaker **1718** may send a corresponding command to the projector device **1702**.

In some example embodiments, the smart speaker **1718** may send the vocally received command to a cloud server, such as the processor device **1722**, that can generate the appropriate commands to be sent to one or more of the projector devices **1702**, **1704**, **1706**. In some example embodiments, the smart speaker **1718** may provide the network addresses of the projector devices **1702**, **1704**, **1706** and the lighting fixtures **1712**, **1714**, **1716** to the processor device **1722** (e.g., a cloud server) such that the processor device **1722** can send commands and information, video images, etc. (i.e., images) to the appropriate ones of the projector devices **1702**, **1704**, **1706**.

In some example embodiments, the smart speaker **1718** or the processor device **1722** may send dim commands to one or more of the lighting fixtures **1712**, **1714**, **1716** in response to vocal commands received by the smart speaker **1718** to start projection of one or more images by one or more of the projector devices **1702**, **1704**, **1706**. In some example embodiments, the smart speaker **1718** or the processor device **1722** may send undim commands to one or more of the lighting fixtures **1712**, **1714**, **1716** in response to vocal commands received by the smart speaker **1718** to stop projection of one or more images by one or more of the projector devices **1702**, **1704**, **1706**.

In some alternative embodiments, the system **1700** may include more or fewer projector devices and lighting fixtures than shown without departing from the scope of this disclosure. For example, the system **1700** may include just one projector device without departing from the scope of this disclosure. In some alternative embodiments, the handheld device **1708** or the smart speaker **1718** may be omitted without departing from the scope of this disclosure. In some example embodiments, the network device **1720** and the processor device **1722** may be omitted without departing from the scope of this disclosure. In some alternative embodiments, the projector devices **1702**, **1704**, **1706** may be installed in a different configuration than shown without departing from the scope of this disclosure.

FIG. **18** illustrates a lighting and projector system **1800** including recessed projector devices according to another example embodiment. The lighting and projector system **1800** is substantially similar the lighting and projector system **1700** of FIG. **17** and may operate in a substantially similar manner. In some example embodiments, the handheld device **1708** may include a control application **1802** that is executed by the handheld device **1708** to control operations of the recessed projector devices **1702**, **1704**, **1706** in a similar manner as described above with respect to FIG. **17**. The handheld device **1708** may execute the control application **1802** to perform operations described above with respect to FIG. **17**. The handheld device **1708** may also execute the control application **1802** to control operations of the lighting fixtures **1712**, **1714**, **1716**.

In some example embodiments, the handheld device **1708** may associate one or more network addresses of the projector devices **1702**, **1704**, **1706** with particular user inputs as described above with respect to FIG. **17**. For example, the control application **1802** may associate a swipe (e.g., using a finger or a stylus) of the touch-sensitive display screen toward a particular cardinal direction (i.e., north, south, east, or west) with a particular one or more of the projector devices **1702**, **1704**, **1706** and/or a command for the par-

particular one or more of the projector devices 1702, 1704, 1706 to project one or more images, to stop projection of images, etc. By configuring the handheld device 1708 to associate a particular cardinal direction with particular one or more of the projector devices 1702, 1704, 1706 (e.g., using network addresses), the handheld device 1708 can interpret swipes of the screen of the handheld device 1708 in the particular cardinal direction as being directed to the associated one or more of the projector devices 1702, 1704, 1706 regardless of the orientation of the handheld device 1708.

In some example embodiments, the handheld device 1708 may include components that enable the handheld device 1708 to identify cardinal directions of swipes of the touch-sensitive screen of the handheld device 1708. To illustrate, the handheld device 1708 may include a 3-axis accelerometer, a 3-axis gyroscope and a 3-axis geomagnetic sensor that enable the handheld device 1708 to identify cardinal directions of swipes of the touch-sensitive screen of the handheld device 1708 regardless of the orientation of the handheld device 1708. In response to such swipes of the display screen, the handheld device 1708 may transmit commands intended for one or more of the projector devices 1702, 1704, 1706.

In some example embodiments, the projector device 1702, 1704, and 1706 may be associated by the handheld device 1708 with swipes in the directions of north, west, and south, respectively. In some example embodiments, the handheld device 1708 may also be configured to associate one or more projector devices with swipes in intercardinal directions, i.e., northeast, southeast, southwest, and northwest. Swipes of the screen of the handheld device 1708 in an associated intercardinal direction may result in the handheld device 1708 transmitting a command to the associated projector device.

In some alternative embodiments, the system 1700 may include more or fewer projector devices and lighting fixtures than shown without departing from the scope of this disclosure. For example, the system 1700 may include just one projector device without departing from the scope of this disclosure. In some alternative embodiments, the handheld device 1708 or the smart speaker 1718 may be omitted without departing from the scope of this disclosure. In some example embodiments, the network device 1720 and the processor device 1722 may be omitted without departing from the scope of this disclosure. In some alternative embodiments, the projector devices 1702, 1704, 1706 may be installed in a different configuration than shown without departing from the scope of this disclosure.

FIG. 19 illustrates a lighting and projector system 1900 including recessed projector devices according to another example embodiment. In some example embodiments, the system 1900 includes projector devices 1902, 1904 and lighting fixtures 1912, 1914, 1922 that are recessed in a ceiling 1910. For example, the recessed projector devices 1902, 1904 may each be one of the recessed lighting and projector fixtures described above and may be installed in the ceiling 1910 in a similar manner as described above. The system 1900 may also include gesture recognition sensors 1916, 1918, 1920. For example, the gesture recognition sensor 1916 may be communicably coupled to the projector device 1904, and the gesture recognition sensor 1918 may be communicably coupled to the projector device 1902. For example, the gesture recognition sensor 1916 may be integrated into the projector device 1904, and the gesture recognition sensor 1918 may be integrated into the projector

device 1902. The gesture recognition sensor 1920 may be communicably coupled with one or both of the projector devices 1902, 1904.

In some example embodiments, each of the gesture recognition sensors 1916, 1918, 1920 are capable of identifying and interpreting hand gestures, such as hand gestures 1928, 1930. Alternatively or in addition, the gesture recognition sensors 1916, 1918, 1920 may transmit gesture detection information to the processor device 1722, which may be a local controller or cloud server. For example, the gesture recognition sensors 1916, 1918, 1920 may communicate with the processor device 1722 through the network device 1720.

In some example embodiments, the gesture recognition sensors 1916, 1918, 1920 and/or the processor device 1722 may be configured to interpret particular hand gestures as being directed to one or more of the projector devices 1902, 1904 and/or as particular commands, such as a command to project an image or a light, to stop projection, etc. For example, in response to determining that a particular hand gesture is directed to the projector device 1902 and that it corresponds to a particular command, the gesture recognition sensor 1916 may provide the command to the projector device 1902. Alternatively, the gesture recognition sensor 1916 may provide information derived from the detected gesture to the projector device 1902, and the projector device 1902 can interpret the information to take the appropriate action, such as start projecting an image or a light, stop projection, retrieve information from a cloud server, etc. The other gesture recognition sensors 1918, 1920 may operate in a similar manner with other projector devices to control operations of one or more projector devices.

In some example embodiments, the processor device 1722 may process gesture detection information received from the gesture recognition sensors 1916, 1918, 1920 to identify and interpret hand gestures, and in response, transmit one or more corresponding commands (e.g., project an image, stop projection, etc.) to one or more of the projector devices 1902, 1904 depending on the interpretation of the gesture detection information by the processor device 1722. For example, the processor device 1722 may more reliably identify hand gestures by processing information from multiple gesture recognition sensors.

In some example embodiments, the projector device 1902 may project an image or a light on a surface 1924 in response to a hand gesture being interpreted as a command to project an image or a light. The projector device 1904 may project an image or a light on a surface 1926 in response to a hand gesture being interpreted as a command to project an image or a light. The projector devices 1902, 1904 similarly stop projection of images in response to the same hand gesture or a different hand gesture from the hand gesture that resulted in the projection of images.

In some example embodiments, one or more of the lighting fixtures 1912, 1914, 1922 may dim their lights in response to the projector devices 1902, 1904 projecting one or more images. For example, the projector devices 1902, 1904, the gesture recognition sensors 1916, 1918, 1920, and or the processor device 1722 may transmit dim and undim commands to the lighting fixtures 1912, 1914, 1922 depending on, for example, whether the projector devices 1902, 1904 are starting or stopping projecting images.

In some example embodiments, the system 1900 may include more or fewer projector devices and lighting fixtures than shown. In some example embodiments, some hand gestures may be associated with one projector device, and other hand gestures may be associated with another projec-

tor device. For example, a set of hand gestures may be associated with projecting an image or a light, stopping projecting of images, projecting particular images (e.g., weather information, etc.), and other operations related to the projector device **1902**. Another set of hand gestures may be associated with similar operations related to the projector device **1904**.

In some alternative embodiments, the network device **1720** and the processor device **1722** may be omitted without departing from the scope of this disclosure. In some alternative embodiments, the projector devices **1902**, **1904**, the gesture recognition sensors **1916**, **1918**, **1920**, and the lighting fixtures **1912**, **1914**, **1922** may be installed in a different configuration than shown without departing from the scope of this disclosure.

FIG. **20** illustrates a lighting and projector system **2000** including recessed projector devices according to another example embodiment. In some example embodiments, the system **2000** includes recessed projector devices **2002**, **2004**. For example, the recessed projector devices **2002**, **2006** may each be one of the recessed lighting and projector fixtures described above and may be installed in ceiling **2010**, **2012** in a similar manner as described above. In some example embodiments, the system **2000** may also include occupancy sensors **2006**, **2008**. For example, the occupancy sensor **2006** may be integrated in the projector device **2002**, and the occupancy sensor **2008** may be integrated in the projector device **2004**. Alternatively, the occupancy sensors **2006**, **2008** may be standalone sensors.

In some example embodiments, the occupancy sensors **2006**, **2008** may each include one or more of a motion sensor, a Bluetooth Low Energy unit, visible light unit, a camera, etc. that can be used to detect occupancy of a space as can be readily understood by those of ordinary skill in the art with the benefit of this disclosure. For example, the occupancy sensors **2006**, **2008** may be passive infrared sensors.

In some example embodiments, the recessed projector device **2002** may be positioned to project an image or a light on a surface **2018** in a room **2014**, and the recessed projector device **2004** may be positioned to project an image or a light on a surface **2020** in a room **2016**. In some example embodiments, the sensor **2006** may control operations of the recessed projector device **2002**, and the sensor **2008** may control operations of the recessed projector device **2004**.

To illustrate, the projector device **2002** may project an image or a light (e.g., a shaped light) in response to an occupancy detection by the occupancy sensor **2006**. For example, the occupancy sensor **2006** may send a command or other detection indicator information to the projector device **2002** in response to detecting one or more occupants in the room **2014**. The projector device **2002** may project an image or a light immediately or a period of time (e.g., 30 seconds) after receiving the command or information from the occupancy sensor **2006**.

The projector device **2002** may stop projecting the image or the light when no detection of occupancy of the room **2014** is indicated by the occupancy sensor **2006** for a period of time (e.g., 20 minutes). In some example embodiments, the projector device **2002** may stop projecting the image or the light in the absence of a detection of occupants for a time period regardless of whether the projector device **2002** started projecting the image or the light in response to a detection by the sensor **2006**.

In some example embodiments, the projector device **2004** may project an image or a light (e.g., a shaped light) in response to an occupancy detection by the occupancy sensor

**2008**. For example, the occupancy sensor **2008** may send a command or other detection indicator information to the projector device **2004** in response to detecting one or more occupants in the room **2016**. The projector device **2004** may project an image or a light immediately or for a period of time (e.g., 20 seconds) after receiving the command or information from the occupancy sensor **2008**.

The projector device **2004** may stop projecting the image or the light when no detection of occupancy of the room **2016** is indicated by the occupancy sensor **2008** for a period of time (e.g., 10 minutes). In some example embodiments, the projector device **2004** may stop projecting the image or the light in the absence of a detection of occupants for a time period regardless of whether the projector device **2004** started projecting the image or the light in response to a detection by the sensor **2008**.

In some example embodiments, the source of the image projected by the recessed projector devices **2002**, **2004** may be a video camera **2028** of a doorbell device **2022** or a video camera of a security system. For example, when a person **2026** rings the doorbell device **2022**, the doorbell device **2022** may send a message or a command to one or both projector devices **2002**, **2004** or to one or more other devices such as the sensors **2006**, **2008**, the processor device **1722** (operating as a local or cloud server), a handheld device, etc. The doorbell device **2022** may also send a video stream to the projector devices **2002**, **2004** or to the processor device **1722**, a handheld device, etc. When the sensor **2006** detects a person **2024** in the room **2014**, the sensor **2006** may provide a command to the projector device **2002** to project an image or otherwise indicate the detection of one or more occupants to the projector device **2002**. In response, the projector device **2002** may project the image (i.e., the video showing the person **2026**). Because no occupants are detected by the sensor **2008**, the projector device **2004** may not project the video showing the person **2026**. If the person **2024** or another person enters the room **2016**, the projector device **2004** may start projecting the video following the detection of the person **2024** or the other person by the sensor **2008**.

In some example embodiments, the doorbell device **2022** and the projector devices **2002**, **2004** may communicate through the network device **1720** or via wired connections. In some example embodiments, the sensors **2006**, **2008** may send detection information to the processor device **1722** that may transmit one or more commands to the projector devices **2002**, **2004** depending on the information from the sensor **2006**, **2008**. For example, the processor device **1722** may transmit a command to the projector device **2002** to project an image in response to the sensor **2006** indicating to the processor device **1722** a detection of one or more occupants. The processor device **1722** may transmit a command to the projector device **2004** to project an image in response to the sensor **2008** indicating to the processor device **1722** a detection of one or more occupants. The processor device **1722** may transmit a command to stop projecting an image if no indications of occupants are received for a period of time or if an indication of no occupants is received for a period of time.

To illustrate, the sensor **2006** may indicate the detection of one or more occupants to the processor device **1722**. For example, the processor device **1722**, which also receives a message when the person **2026** rings the doorbell device **2022**, may send a command to the projector device **2002** to project the video stream based on both the occupancy detection by the sensor **2006** and the doorbell indication from the doorbell device **2022**. The video stream may be provided to

the projector device **2002** directly from the doorbell device **2002** or indirectly through the processor device **1722**. The processor device **1722** may operate in a similar manner to control the operation of the projector device **2004**. In some example embodiments, a handheld device, such as the handheld device **1708**, may operate in a similar manner as the processor device **1722** to control the operation of the projector devices **2002**, **2004**. In some example embodiments, the projector devices **2002**, **2004** may operate with a security system in a similar manner as described with respect to the doorbell device **2022**.

In some example embodiments, the smart speaker **1718** may operate in a similar manner as described above to control operations of the projector devices **2002**, **2004**. In some example embodiments, a control device, such as the handheld device **1708**, may be used in a similar manner as described above to control operations of the projector devices **2002**, **2004**. In some example embodiments, the projector devices **2002**, **2004** may also be controlled based on time scheduled and/or timers. In some example embodiments, lighting fixtures in the rooms **2014**, **2018** may be dimmed and undimmed in a similar manner as described above.

In some example embodiments, the system **2000** may include more or fewer projector devices and sensors than shown without departing from the scope of this disclosure. In some alternative embodiments, the network device **1720** and the processor device **1722** may be omitted without departing from the scope of this disclosure. In some alternative embodiments, the projector devices and sensors may be installed in a different configuration than shown without departing from the scope of this disclosure.

Referring to FIGS. **17-20**, in some example embodiments, a method of operation of the lighting and projector systems **1700**, **1800**, **1900**, **2000** may include receiving, by a first one of the recessed projector devices of the systems **1700**, **1800**, **1900**, **2000**, an image to be projected. For example, the image may be or may include weather information, traffic information, a video, a picture, etc. The image may be received from an image source such as a laptop, a handheld device, a cloud server, a local server, a video camera, etc. The method of operation of the lighting and projector systems **1700**, **1800**, **1900**, **2000** may also include receiving, by a second one of the recessed projector devices of the systems, the image to be projected. For example, the second recessed projector device may receive the same image as received by the first recessed projector device from the same source or a different source. Alternatively, the second recessed projector device may receive a different image from the same source or a different source. The method may also include receiving, by the first recessed projector device, a command to project the image. For example, the command may be received from the handheld device **1708**, the smart speaker **1718**, one or more of the gesture recognition sensors **1916**, **1918**, **1920**, the occupancy sensors **2006**, **2008**, a local or cloud controller (e.g., the processor device **1722**), a security system, a doorbell device, etc. In response to the received command, the first recessed projector device may project the image on a surface (e.g., the surface **1724**, **1924**, **2018**) below the first recessed projector device. The method may also include receiving by the second recessed projector device a second command to project the same or a different image. For example, the second command may be received from the handheld device **1708**, the smart speaker **1718**, one or more of the gesture recognition sensors **1916**, **1918**, **1920**, the occupancy sensors **2006**, **2008**, a local or cloud controller (e.g., the processor device **1722**), a security system, a

doorbell device, etc. In response to the second command, the second recessed projector device may project the same or a different image on a surface (e.g., the surface **1726**, **1926**, **2020**) below the second recessed projector device. In some example embodiments, the method may also include receiving, by the first recessed projector device, a third command to stop projecting the image and stopping projecting the image in response to the third command.

FIG. **21** illustrates the lighting and projector fixture **400** projecting a shaped light according to an example embodiment. FIGS. **22A-22F** illustrate examples of shaped lights according to an example embodiment. In some example embodiments, the lighting and projector fixture **400** includes a projector device **302** (or another projector device) that can emit or project a shaped light **2102**. For example, the shaped light **2102** may serve as an accent light for an artwork **2104**, to provide directions, to provide particular color lights, etc. In some example embodiments, the shaped light may be a highly focused light. For example, the shaped light **2102** may correspond to one or more of the shaped lights shown in FIGS. **22A-22F**. The shaped light **2102** may have different shapes that correspond to different areas of a poster, a painting, etc.

In some example embodiments, the shaped light **2102** may be a framed light, where the light is shaped as a frame. For example, the shaped light **2102** may be a framed light, such as the framed light shown in FIG. **22F**, that can be projected as a frame of the artwork **2104** or may be used for other purposes without departing from the scope of this disclosure.

In some example embodiments, other lighting and projector fixtures described above (e.g., the lighting and projector fixtures **300**, **500**, **600**, **900**, etc.) may provide shaped lights including the shaped lights shown in FIGS. **22A-22F** and framed lights. For example, shaped lights projected on a floor or a wall may be used to provide directions, for entertainment, etc. The lighting and projector fixture **400** may project the shaped light using a particular lens designed to produce the shaped light, a particular shape image, or other means as may be contemplated by those of ordinary skill in the art with the benefit of this disclosure.

FIG. **23** illustrates a lighting and projector system **2300** including a lighting and projector fixture **2302** according to another example embodiment. In some example embodiments, the lighting and projector fixture **2302** includes a lighting and projector module **2304** and a power and control module **2306**. The lighting and projector module **2304** and the power and control module **2306** may be positioned in a housing **2308** that is attached to a pole **2310** that extends up from the ground **2314**.

In some example embodiments, the lighting and projector fixture **2302** may correspond to or may include the lighting and projector device **200** of FIG. **2**. For example, the lighting and projector module **2304** may correspond to the lighting and projector module **202** of FIG. **2**. The power and control module **2306** may include the power source **204** and the controller **206**.

In some example embodiments, the lighting and projector module **2304** may operate to provide a light for illumination in one mode and may operate to project information (e.g., safety related information) in another mode. For example, the lighting and projector module **2304** may provide a light to illuminate the ground **2314** and/or a wall **2316**. When operating as a projector, the lighting and projector module **2304** may project information, etc. on the ground **2314** and/or on the wall **2316**. The orientation of the lighting and projector module **2304** may be adjustable along the path

illustrated by the arrow **2320** to direct the light provided by the lighting and projector module **2304** in a desired direction.

In some example embodiments, an antenna **2312** may be used to wirelessly receive and transmit signals. Alternatively or in addition, the lighting and projector fixture **2302** may receive, via a wired connection, lighting control and other instructions as well as images to be projected. The antenna **2312** may be omitted or may be positioned at a different location.

In some example embodiments, the lighting and projector fixture **2302** may include a heat sink **2318** that is used to dissipate heat from the lighting and projector fixture **2302**. In some example embodiments, the housing **2308** may serve as a heat sink. For example, a fan that is ordinarily included with standalone projectors may be omitted or a smaller fan may be used.

In some alternative embodiments, the heat sink **2318** may be omitted. In some alternative embodiments, the lighting and projector system **2300** may be implemented as an indoor lighting system instead of the outdoor light system shown in FIG. **23**.

FIG. **24** illustrates a lighting and projector system **2400** including a lighting and projector fixture **2402** according to another example embodiment. In some example embodiments, the lighting and projector fixture **2402** includes a projector module **2404**, a lighting module **2406**, and a power and control module **2408**. The projector module **2404**, the lighting module **2406**, and the power and control module **2408** may be positioned in a housing **2410** that is attached to a pole **2418** that extends up from the ground **2414**.

In some example embodiments, the lighting module **2406** may provide an illumination light, and the projector module **2404** may project an image, for example, on the ground **2414** and/or on a wall **2416**. The orientation of the projector module **2404** may be adjusted to direct the projection toward a desired surface.

In some example embodiments, the projector module **2404** and the lighting module **2406** may include separate light sources. Alternatively, the projector module **2404** may not include a light source, where a portion of the light emitted by the light source of the lighting module **2406** is directed within the housing **2410** to be used by the projector module **2404** for projection. In some alternative embodiments, the lighting module **2406** may not include a light source, where a portion of the light emitted by the light source of the projector module **2404** is directed within the housing **2410** to be emitted by the lighting module **2406** for illumination. In some example embodiments, the lighting and projector system **2400** may be used in a parking lot or garage to provide directions (e.g., via arrows projected down on the ground) to available parking spaces.

In some example embodiments, the lighting and projector fixture **2402** may include a heat sink **2420** that is used to dissipate heat from the lighting and projector fixture **2402**. In some example embodiments, the housing **2410** may serve as a heat sink. For example, a fan that is ordinarily included with standalone projectors may be omitted or a smaller fan may be used.

In some alternative embodiments, the heat sink **2420** may be omitted. In some alternative embodiments, the lighting and projector system **2400** may be implemented as an indoor lighting system instead of the outdoor light system shown in FIG. **24**.

FIG. **25** illustrates a block diagram of a lighting and projector fixture **2500** according to an example embodiment. For example, the lighting and projector fixture **2500** may

correspond to the lighting and projector fixture **2402** of FIG. **24**. In some example embodiments, the lighting and projector fixture **2500** includes a lighting and projector module **2502**, the power source **204**, and the controller **206**. The lighting and projector module **2502** includes the lighting module **210** and a projector module **2504**. In some example embodiments, the power source **204** and the controller **206** may be included in the power and control module **2408** of FIG. **24**.

In some example embodiments, the power source **204**, the controller **206**, and the lighting module **210** operate in substantially the same manner as described above. The projector module **2504** includes a light source **2506** that is used to provide the light **2518** used to project an image. The light source **214** of the lighting module **210** provides the light **226** that is used for illumination. The lighting and projector fixture **2500** can provide the illumination light **226** and project images independently as well as simultaneously.

In some alternative embodiments, the components of the lighting and projector fixture **2500** may be connected in a different configuration than shown without departing from the scope of this disclosure. In some alternative embodiments, the lighting and projector fixture **2500** may include other components without departing from the scope of this disclosure. In some alternative embodiments, some of the components of the lighting and projector fixture **2500** may be integrated into a single component without departing from the scope of this disclosure. In some alternative embodiments, some of the components of the lighting and projector fixture **2500** may be replaced by multiple components without departing from the scope of this disclosure.

FIG. **26** illustrates a system **2600** of lighting and projector systems **2602**, **2604** according to another example embodiment. In some example embodiments, the lighting and projector systems **2602**, **2604** may each correspond to the lighting and projector systems **2300**, **2400**. As illustrated in FIG. **26**, the lighting and projector system **2602** may project a message **2612** on a walkway **2606** indicating an entrance to a building **2610**. The lighting and projector system **2604** may project a message **2614** on the walkway **2606** indicating an exit from the building **2610**.

The lighting and projector systems **2602**, **2604** may project other images on the walkway **2606** and/or on the street **2608**. The lighting and projector systems **2602**, **2604** may also emit illumination lights on to the walkway **2606** or the street **2608** at the same time as the messages **2612**, **2614** or alternatively.

In some example embodiments, the lighting and projector systems **2602**, **2604** may emit other messages, warnings, other types of images, etc. In some example embodiments, the lighting and projector systems **2602**, **2604** may be used in a parking lot or garage to provide directions (e.g., via arrows projected down on the ground) to available parking spaces. In some example embodiments, the lighting and projector systems **2602**, **2604** may be responsive to integrated or external motion sensors to emit illumination lights and project images. In some example embodiments, the system **2600** may include just one lighting and projector system or more than two lighting and projector systems.

FIG. **27** illustrates a lighting and projector system **2700** according to another example embodiment. The lighting and projector system **2700** may include a lighting module **2702** and a projector module **2704**. The projector module **2704** may include a light source **2706**, and the lighting module **2702** may include a light source **2708**. The lighting and projector system **2700** may also include a power and control

module **2710** that provides power to the lighting module **2702** and the projector module **2704**.

In some example embodiments, the lighting module **2702** and the power and control module **2710** may be inside a housing **2712**, and the housing **2712** may be attached to a pole **2716**. The projector module **2704** may be attached to the pole **2716**. The projector module **2704** may be at least partially positioned within a hollow cavity of the pole **2716**. The pole **2716** may serve as a heat sink for the projector module **2704**. For example, by using the pole **2716** as a heat sink, a fan that is ordinarily included with standalone projectors may be omitted or a smaller fan may be used.

Electrical cable **2718** may provide AC power to the power and control module **2710**, and the power and control module **2710** may generate DC power to power the lighting module **2702** and the projector module **2704**. The power and control module **2710** may provide different power levels that are suitable for the lighting module **2702** and the projector module **2704**. For example, the power and control module **2710** may provide a first voltage level to the lighting module **2702** and a second voltage level to the projector module **2704**. In some alternative embodiments, the projector module **2704** may generate DC power from the AC power received via a connection **2722** instead of receiving DC power from the power and control module **2710**.

In some example embodiments, the power and control module **2710** may receive lighting control and images (e.g., information, pictures, etc.) to be projected wirelessly or via a wired connection. The power and control module **2710** may control operation of the lighting module **2702** to control the light emitted by the light source **2708** based on received lighting instructions, programmed schedules, sensor outputs, etc. For example, the power and control module **2710** may control whether the light source **2708** emits a light as well as the intensity level, CCT, color, etc. of the light emitted by the light source **2708**.

The power and control module **2710** may control operations of the projector module **2704** based on received instructions and information, programmed schedules, sensor outputs, etc. For example, the power and control module **2710** may control whether the projector module **2704** projects a message **2728** (e.g., traffic information, weather information, safety related information, advertisement, etc.) on a surface, such as a billboard **2726**. The power and control module **2710** may provide to the projector module **2704** the images (e.g., information, pictures, etc.) to be projected.

FIG. **28** illustrates a block diagram of a lighting and projector system **2800** according to an example embodiment. For example, the lighting and projector system **2800** may correspond to or may be included in the lighting and projector system **2700** of FIG. **27**.

In some example embodiments, the lighting and projector system **2800** includes a lighting module **2802**, a projector module **2804**, the power source **204**, and the controller **206**. In some example embodiments, the power source **204** and the controller **206** may be included in the power and control module **2710** of FIG. **27**.

In some example embodiments, the power source **204** and the controller **206** operate in substantially the same manner as described above. In some example embodiments, the lighting module **2802** operates in substantially the same manner as described above with respect to the lighting module **210**.

In some example embodiments, the projector module **2804** includes a light source **2806** that provides a light **2812** for projecting an image. The light source **2808** of the lighting

module **2802** provides a light **2810** that is used for illumination. The lighting and projector system **2800** can provide the illumination light **2810** and project images (e.g., information, pictures, etc.) independently as well as simultaneously.

In some alternative embodiments, the components of the lighting and projector system **2800** may be connected in a different configuration than shown without departing from the scope of this disclosure. In some alternative embodiments, the lighting and projector system **2800** may include other components without departing from the scope of this disclosure. In some alternative embodiments, some of the components of the lighting and projector system **2800** may be integrated into a single component without departing from the scope of this disclosure. In some alternative embodiments, some of the components of the lighting and projector system **2800** may be replaced by multiple components without departing from the scope of this disclosure.

Although particular embodiments have been described herein in detail, the descriptions are by way of example. The features of the example embodiments described herein are representative and, in alternative embodiments, certain features, elements, and/or steps may be added or omitted. Additionally, modifications to aspects of the example embodiments described herein may be made by those skilled in the art without departing from the spirit and scope of the following claims, the scope of which are to be accorded the broadest interpretation so as to encompass modifications and equivalent structures.

What is claimed is:

1. A projection system, comprising:

a recessed projection fixture, comprising:

a lighting module configured to emit a light; and

a projection module configured to project an image,

wherein the light emitted by the lighting module is used for projecting the image and for illumination;

an image source device configured to send information related to an availability of the image in response to an indication of a presence of an entity at a location of the image source; and

a sensor, wherein the projection module projects the image in response to an occupancy detection by the sensor and the information from the image source device and wherein the recessed projection fixture is oriented to direct the image toward a surface below the recessed projection fixture.

2. The projection system of claim 1, wherein the image source device includes a doorbell camera device or a security camera device.

3. The projection system of claim 1, further comprising a second lighting and projector device positioned to project a second image based on a programmed schedule.

4. The projection system of claim 3, wherein the image includes weather information or traffic information.

5. The projection system of claim 1, wherein the projection module is configured to project a second image instead of the image in response to a user input received from a control device.

6. A projection system, comprising:

a projector device for recessed installation behind a ceiling;

an occupancy sensor communicably coupled to the projector device;

an image source device configured to send information related to an availability of the image in response to an indication of a presence of an entity at a location of the image source device; and

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a control device configured to control projections of an image by the projector device in response to an occupancy detection by the occupancy sensor and the information from the image source device, wherein the projector device is designed to project the image toward a surface below the ceiling.

7. The projection system of claim 6, further comprising a mounting frame designed to be positioned behind a ceiling, wherein the projector device is positioned on the mounting frame.

8. The projection system of claim 6, further comprising a housing for recessed installation behind a ceiling, wherein the projector device is positioned at least partially inside the housing.

9. The projection system of claim 6, wherein the projector device is further configured to project the image based on a programmed schedule.

10. The projection system of claim 6, wherein the projector device is configured to project a second image in response to a user command received from a control device.

11. The projection system of claim 6, wherein the projector device is configured to stop projecting the image when no detection of occupancy is indicated by the occupancy sensor for a period of time.

12. The projection system of claim 6, further comprising a second projector device for recessed installation behind the ceiling, wherein the second projector device is configured to project the image in response to an occupancy detection by a second occupancy sensor and based on the information from the image source device related to the availability of the image and wherein the second projector device is designed to project the image toward a second surface below the second projector device.

13. A method of operation of a projection system, the method comprising:

receiving, by a projection fixture, a command to project an image, the projection fixture comprising a recessed projector device;

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receiving, by the projection fixture, the image from an image source device, wherein the command is generated based on information from the image source device related to an availability of the image and based on an occupancy detection by an occupancy sensor at a location of the projection fixture and wherein the information from the image source device is sent by the image source device in response to an indication of a presence of an entity at a location of the image source device; and

projecting, by the projection fixture, the image on a surface below the recessed projector device, wherein the projection fixture is configured to stop projecting of the image if no occupant is detected for a period of time.

14. The method of claim 13, wherein the recessed projector device is positioned at least partially inside a housing recessed behind a ceiling.

15. The method of claim 13, wherein the command is received from a central controller configured to communicate with the image source device and the projection fixture.

16. The method of claim 13, wherein the command is received from a mobile device configured to communicate with the image source device and the projection fixture.

17. The method of claim 13, wherein the projection fixture is configured to receive a second command from a hand gesture detection device or a smart speaker.

18. The method of claim 13, wherein the image source device includes a doorbell camera device or a security camera device.

19. The method of claim 13, wherein the indication of the presence of the entity is an input provided to the image source device by the entity.

20. The projection system of claim 6, wherein the image source device includes a doorbell camera device or a security camera device.

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